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GENERAL

499 Nuclear fission-a source of competitive energy. T. R. Hogness. Petroleum Engr. 21, A-56, 61, 63, 64, 68 and 70(1949) May.

The author presents figures on the total energy consumed in the United States in 1946 in BTU's and discusses the possibility of fulfilling these requirements with nuclear energy in the period beyond 1970. He discusses the process of fission, namely, the pile or reactor, the nuclear utilization of waste neutrons to convert U^{238} and thorium to nuclear or "atomic" fuels, the power reactor, the breeding principle and radioactivity problems. Competitive costs of fuels and fuel reserves are also presented.

500 The present status of atomic power. Norman Hilberry. Combustion 20, 47-50(1949) June.

A comparison of the operation of a steam boiler with a nuclear reactor is made. The breeding process is described, and some of its future possibilities are outlined. The role of international affairs in the future development of atomic power is noted, and four types of nuclear reactors now under development are mentioned.

501 Uranium and atomic energy. W. H. Dennis. Mine and Quarry Engr. 15, 211-8(1949) July.

The concentration methods used in obtaining U_3O_8, the preparation of the metal from its oxide, and the separation of 235 and 238 are described. The author discusses two methods for separating the isotopes of uranium; namely, gaseous diffusion and electro-magnetic. The formation of plutonium (239) is explained and since it is not an isotope, it can be extracted by chemical methods. The makeup of the nucleus is clearly presented along with the principle for transforming atomic mass into energy by nuclear bombardment ($E = MC^2$). A description of the first atomic energy machine employing a chain reaction is given. It was made up of grains of uranium embedded in graphite bricks. Later piles now operating at Clinton and Hanford in the U.S.A., and Great Britain are cubical in structure. Uranium is utilized in the form of long rods encased in aluminum containers which are slid into channels in the graphite pile. The containers protect the uranium from the cooling water. The reaction of the pile is controlled by inserting or removing cadmium rods from the lattice.

The breeding principle, industrial utilization, radioactive isotopes and the military usage are also discussed. In conjunction with military usage, the author briefly discusses the critical size and states that the amount of uranium used in the atomic bomb is 135 pounds.

BIOLOGY AND MEDICINE

502 Some effects of x-radiation on water and electrolyte metabolism in the rat. Abraham Edelmann. AECU-261, nd. 1p.

This document is in abstract form; it is reproduced below in its entirety.

The intake of distilled water, 1% NaCl solution, and food and the excretion of urinary Na, K, Cl and water by male albino rats were determined daily previous to and following exposures to 100, 250, 800, and 1000 r of x-rays. Polydipsia and polyuria occurred during the first and fifth 24-hour period following radiation. The urinary excretions of Na, K, and Cl were increased at these times. Following doses of 500 r or more there is a relative and absolute decrease in intake of the salt solution. This is a monophasic response reaching its minimum at about three days. The salt solution intake returns to previous levels at 5 days. After doses of 100 or 250 r, the 1% NaCl solution intake follows the biphasic curve of water intake. Food intake decreased for 2 days following radiation and then returned to normal in about two days. Body weight changes paralleled the food consumption.

BIOLOGY AND MEDICINE (continued)

503 Time-dose study of biochemical responses of rats to x-radiation. N. North and L. F. Nims. AECU-266, nd. 1p.

This document is in abstract form; it is reproduced below in its entirety.

A time-dose study of biochemical responses of the adrenal-pituitary system in fasted rats following whole body x-radiation indicates a pattern of changes comparable to that following other stresses. Male albino rats were subjected to radiation doses of 500 to 200 r at a rate of 50 r/min and sacrificed at periods of time ranging from 3 to 48 hr following exposure. Analyses of tissue constituents show an immediate and progressive increase in liver glycogen and no change in testis glycogen. There is a simultaneous decrease in the adrenal and liver cholesterol but little change in the testis cholesterol and a late increase in the plasma cholesterol. The adrenals also show an initial decrease in ascorbic acid content with a subsequent return to normal, while little variation from the unirradiated controls is seen in pituitary, liver, or testis ascorbic acid. There are no evident effects of radiation on total body, adrenal, or pituitary weights in fasted animals.

504 The effect of absorbed radioactive phosphorus (P^{32}) on the genetics of E. coli. Benjamin A. Rubin and Paul Steinglass. AECU-269, nd. 1p.

This document is in abstract form; it is reproduced below in its entirety.

The intent of this study was to determine whether the genetic effects of P^{32} could be accounted for by β-ionization alone. A mathematical basis was developed for the detection of the mutagenic effect of chemical transmutation in the presence of ionizing radiation. In order to fulfill the requirements of the theoretical calculation, experiments were designed to produce great differences in the amounts of radioactive material taken up by the bacteria. This was achieved by varying the concentration of total phosphorus but maintaining a constant P^{32} level. A quantitative genetic effect was sought in the ability of the organisms to synthesize certain metabolites, utilize carbohydrates, and resist antibacterial agents. Results indicated that an effect beyond that attributable to ionization was present. The data, however, were complicated by the necessity for post treatment before mutants could be detected. The most effective post treatment was fractional heat killing, which sometimes caused great increases in mutation rate. The significance of this necessity may be related to the "nuclear" organization of bacteria since it was noted that the kinetics of the heat killing did not resemble a first order reaction but indicated the presence of multiple genetic and heat sensitive loci in each organism. Cultures grown in P^{32} and subsequently reduced with heat to about 1% of the original population had a total of more mutants than a culture before either treatment.

505 Effects of x-rays upon the fresh-water snail, Radix japonica. Kelshaw Bonham. AECU-309, May 16, 1949. 33p.

Radix japonica (Jay) from a creek in Richland, Washington were x-rayed with a Coolidge tube at the approximate rates of 120 or 500 r/min using 200 pkv and 20 ma with filters of 0.5 mm of copper and 1 mm of Al. In 3 experiments involving 162 adult snails and graduated series of doses up to 80,000 r, mortalities significantly higher than in the controls were observed in groups receiving 10,000 r or more. Egg masses similarly x-rayed with doses of 180 r, 1,000 r, or 10,000 r were retarded in their development as compared to the controls in the groups receiving 1,000 r and 10,000 r. Crawling activity of the newly hatched young was inhibited only in the 10,000 r group. Ratio of hatched to unhatched was inversely related to exposure.

506 The effect of adrenalectomy upon survival of rats after x-radiation. Abraham Edelmann. AECU-325, nd. 3p.

Bilaterally adrenalectomized male albino rats (Sprague-Dawley) were given 650 r of whole body x-radiation. The average survival of the adrenalectomized irradiated rats was 4.1 days as compared to 7.8 days for the adrenalectomized controls. Subjection of these data to an analysis of variance reveals that the irradiation significantly shortened the lives of the adrenalectomized rats.

BIOLOGY AND MEDICINE (continued)

507 Observations of the blood of cyclotron workers. M. Ingram and S. W. Barnes. AECU-334, nd. 3p.

This document is reproduced below in its entirety.

Attention is called to the finding of two types of unusual cells in the blood of personnel of the 130 in. cyclotron at Rochester, New York. These are, respectively, very early mononuclear cells and cells which appear to be lymphocytes with bilobed or double nuclei. These cells, particularly the latter, occur in very small numbers, and it has been necessary to inspect several thousand leukocytes from each person in order to be assured of the finding. The "early mononuclear cells" are large, peroxidase negative, have deeply basophilic cytoplasm and no nucleoli. The "lymphocytes with bilobed nuclei" tend to be somewhat larger than typical large lymphocytes. The nuclei stain slightly lighter than the nuclei of the other lymphocytes but are similar in consistency and have no nucleoli. The cytoplasm is clear, basophilic, peroxidase negative, and commonly contains a few typical azurophilic granules.

Both kinds of cells have been found in individuals not associated with the cyclotron who have abnormal blood smears due to infections, specifically in several cases of infectious mononucleosis and in one case of acute pharyngitis due to Hemolytic H. Influenza. There is, however, no indication that the findings in cyclotron personnel are due to infections.

Early mononuclear cells are occasionally found in routine films of "normal blood," however, lymphocytes with bilobed nuclei have not, to our knowledge, been described previously, and it is felt that they represent a true departure from the usual or normal blood picture. Although it is not possible to draw any conclusions relative to the significance of these cells as indicators of radiation damage, the findings may conceivably have such significance, and are presented at this time so that they may come to the attention of responsible individuals associated with cyclotrons in other institutions.

508 The atomic bomb's effects on plants and soils. Francis M. Jornlin. Fertilizer Review 23, No. 4, 7-11, 14; No. 5, 7-9, 11-3(1948).

The possible effects of radioactivity on plants and soils are discussed, together with an investigation of the claims of Mr. Takeo Furuno in Nagasaki that the crop yields after the atomic bombing were accelerated. A description is given of the heat, radiations, and blasts produced by the bombs at Hiroshima and Nagasaki, with respect to their immediate and residual influence on plants, seeds, and soil at various distances from the centers of the blasts. Seeds and other organisms below the soil surface received little irradiation; many plant abnormalities were noted in new sproutings soon after the radiations. The soil at 3,936 ft from the center of the blast showed little radioactivity two months after the bombing, and no activity one year after the bombing. The increased yields in Furuno's fields are believed to be due to large amounts of fertilizer, in the form of potash and $(NH_4)_2SO_4$, that he added to the soil. Carefully controlled research is now in progress to establish more definite facts concerning the biological effects of the bombing.

509 Biological deep-dose measurements of electron radiation of 5 million volts. R. Glocker, K. Gund, H. Langendorff, and F. Wachsmann. Strahlentherapie 78, 321-6(1949) (in German).

A method is described for the measurement of the effects and the intensity of the radiations from a 5-million volt source. This method consists of the irradiation of the eggs of the Drosophila fly; the mortality rates of the eggs are taken at different roentgen intensities and curves are included. Eggs were also placed in water solution or other media of similar density at different depths. The curves plotted for these conditions reached a maximum at a definite medium depth and were essentially the same in characteristics for radiations of 1.6 million and 5 million volts. 20 references.

BIOLOGY AND MEDICINE (continued)

510 The blood changes in roentgen personnel. J. Bourret. Deut. med. Wochschr. 74, 447 (1949) Apr. 8 (in German).

For 6 years at the Civil Hospital at Lyon, a semi-annual blood check-up has been pursued in order to determine the amount of radiation exposure the roentgen personnel have suffered from roentgen rays and radioactive materials. Furthermore, a clever device, such as that worn by American Atomic workers is worn by the personnel, a film badge which indicates an exposure to the rays. However, it has been found that the weekly exposure of the personnel is between 1/4 and 1/100 r, well within the 1 r weekly tolerance limit. Workers specializing in roentgen diagnosis of the digestive tract encountered the largest amount of exposure. Even here, the systematic blood control system showed no serious damage from ray exposure.

511 Concerning information of a cold-agglutination in vitro after roentgen radiation of blood serum. Adolf Frank and Waldemar Punin. Klin. Wochschr. 27, 121-2(1949) Feb. 15 (in German).

Some pathological agglutinable substances were drawn upon in order to aid in the clarification of etiologically confused anemia. Experimental investigations concerned with the behavior of auto-agglutination show that serum containing agglutinating substances and agglutinable erythrocytes are influenced through the use of roentgen radiations. In order to test the possibility of an artificial cold-agglutination under the influence of roentgen radiations, investigations were begun. It was possible to authenticate the unobserved agglutination in some instances. In 13 out of 15 cases it was possible to observe an artificial cold-agglutination. The roentgen radiations were the catalytic mechanisms responsible for the change in the intermolecular structure of γ-globulin, this effect consisting in the first part of a re-orientation of the non-specific polyvalent proteins.

512 Effect of urethane combined with x-rays on chick fibroblasts. Edith Paterson and Mary V. Thompson. Nature 163, 563(1949) Apr. 9 (Letter to the editor).

Investigations on chick fibroblasts to determine the mechanism for the similarity of action of x-rays and urethane are presented. Urethane and x-rays evidence similar effects on the inhibition of mitosis by arresting the prophase stage of division. The experiments described show that the fibroblasts treated with urethane undergo chromosome fragmentation and "stickiness" resembling closely the appearances produced by the x-rays. To ascertain if these agents acted through similar mechanisms, a combination of a 0.1% concentration of urethane with x-radiations of 30 r was given to the fibroblasts. The combined effect was less than that produced by the x-rays alone, but more than that elicited by the urethane alone. A dose of 6,000 r x-rays was then given in fractions in combination with 0.2% solutions of urethane. The conclusions drawn from these experiments are that: the x-ray action is incomplete at the time of irradiation, and is capable of being reversed at least in part up to a considerable time (40 minutes) after it has been administered; urethane can itself produce effects similar to those produced by x-rays, and also partially reverse an x-ray effect when the two agents are combined; the experimental evidence produces no basis for expecting an augmented effect when the two agents are used in the treatment of leukemia or other diseases.

513 Effect of x-rays on the incorporation of C^{14} into desoxyribonucleic acid. G. Hevesy. Nature 163, 869-870(1949) June 4 (Letter to the editor).

To determine whether the rate of formation of desoxyribonuleic acid is reduced by the effect of ionizing radiations, C^{14} was incorporated into the purines of desoxyribonuleic acid in the organs of rapidly growing rats after x-radiations. About 5 mc of C^{14} incorporated into the carbonoxyl group of sodium acetate were injected subcutaneously in each of 91 one- to three-week old rats. The rats were killed after a lapse of 6 hr, and the desoxyribonucleotides were separated from the proteins by extraction with trichloroacetic acid; the purines obtained were precipitated and their radioactivity ascertained. Half of the rats had been previously radiated with a dose of 950 r. The amount of labelled purines obtained from the irradiated rats was about half that obtained from the controls. The rate of incorporation of C^{14} into the proteins was not reduced by irradiation; so it is concluded that the rate of formation of

BIOLOGY AND MEDICINE (continued)

desoxyribonucleic acid is reduced by the radiations. This rate reduction of one of the main constituents of cell nuclei may help to explain the blocking effect of irradiation on cell division and the formation of anomalous mitotic products in the irradiated tissue.

514 Further studies on sensitivity of chromosomes to irradiation at different meiotic stages in oöcytes of sciara. Martha L. Bozeman and Charles W. Metz. Genetics 34, 285-314 (1949) May.

X-ray doses of 1,100 r were used to determine the chromosome sensitivity of maturing oöcytes of Sciara ocellaris to radiations. The results indicate that the chromosome sensitivity is almost zero for a long period of time preceding the breakdown of the nuclear membrane at the beginning of the first meiotic division. Then it rises rapidly to a peak, in anaphase, apparently dropping off somewhat in the late anaphase, at which time the mitotic activity is arrested, pending fertilization. Different types of chromosome rearrangments differ greatly in actual frequency. Only one translocation was secured. The author points out that the data suggest the intervention of a cytoplasmic agent which reaches the chromosomes after breakdown of the nuclear membrane and which either induces rearrangments directly, by transmitting an influence already produced by the irradiation, or sensitizes the chromosomes to irradiation so that treatment is effective after, but not before, the entrance of the agent. A third possibility is also considered. 42 references.

515 Histochemical studies on the effect of total body x-irradiation on the alkaline phosphatase. ribo- and desoxyribonucleic acid content of rat liver cells. N. L. Petrakis, F. M. Ashler, and R. L. Ferkel. Naval Radiological Defense Laboratory Report AD-126 (B), June 2, 1949. 18p.

The quantitative histochemical changes in alkaline phosphatase, ribo- and desoxyribonucleic acid were studied in rat liver epithelium for a six-day period after 600r and 1500r total body x-irradiation. With the 600r exposure, a temporary decrease in phosphatase occurred in the nuclei and cytoplasm of these cells during the first six hours. This was followed by an increase above normal at the one, two and six day time intervals studied. A temporary increase in ribonucleic acid concentration occurred during the first 24 hours, followed by a decrease below normal at the two- and six-day interval. The concentration of nuclear desoxyribonucleic acid was decreased at the two- and at the six-day intervals. An immediate increase in all three of the above substances was found during the first 24 hours after 1500r x-irradiation. All observations indicate that the rat liver epithelium is histochemically sensitive to these levels of x-irradiation.

516 The inactivation of an enzyme (Carboxypeptidase) by x- and α-radiation. W. M. Dale, L. H. Gray, and W. J. Meredith. Phil. Trans. Roy. Soc. London 242 33-62(1949) May 31.

The inactivation of aqueous solutions of pure crystalline carboxypeptidase by x-radiation and α-radiation has been studied. It is concluded that in each case the enzyme molecules are inactivated by collision with a labile product resulting from the ionization of the water. The x-ray ionic yield is approximately constant and equal to about 0.18 enzyme molecules inactivated per ion pair of water at all enzyme concentrations between about 2×10^{-4} and 2×10^{-2} g enzyme/ml. At lower concentrations a smaller x-ray ionic yield was observed. At an enzyme concentration of 3×10^{-5} g/ml the results are not affected by the absence of dissolved oxygen. The α-ray ionic yield is only about one-twentieth of the x-ray ionic yield, that is, 0.01 molecules of enzyme inactivated per ion pair of water, and appears to increase about twofold over the concentration range 5×10^{-6} to 5×10^{-3} g enzyme/ml. An attempt is made to correlate the x-ray and α-ray ionic yields with what is known concerning the spatial distribution of the ions. It is concluded that the extremely high concentration of positive ions which forms the core of the α-ray track probably plays a very significant role in the general radiochemistry of α-radiation. The small inactivation of carboxypeptidase brought about by exposure to α-rays could be ascribed to the secondary electrons (δ-rays) which travel clear of the α-ray track and it is not certain that any inactivation of enzyme is brought about by the primary α-ray ionization.

BIOLOGY AND MEDICINE (continued)

517 On the effective cross section of protons and α-rays, as compared with the radiation-sensitive volume, in elementary radio-biological reactions. Kurt Sommermyer. Z. Naturforsch. 3b, 57-9(1948) Jan.-Feb. (in German).

In a previous work (Naturwissenschaften 31, 172(1943)) the author has shown that some radio-biological phenomena cannot be interpreted as due to a saturation effect if the total cross section of the ionizing proton is considered effective. This is confirmed by the findings of Lea (Actions of Radiations in Living Cells, Cambridge 1946) who has shown that, for many processes, the saturation hypothesis explains very well the quantitative data if the biologically effective cross sections of protons and α-rays are disregarded as against the dimensions of the radio-sensitive volume. However, the author objects to the interpretation of this situation offered by Lea, and suggests, as a mechanism of the elementary biophysical reaction involved, a capture of a secondary electron by a complex organic molecule.

518 Performance studies on animals exposed to external radiation. I. Some effects of sublethal total body irradiation upon the performance of exhaustive swimming tests. D. J. Kimeldorf, D. C. Jones, T. A. Gonzalez, J. L. Lee, and M. C. Fishler. Naval Radiological Defense Laboratory Interim Report AD-117 (B), Apr. 29, 1949. 21p.

The ability of rats to perform standardized exhaustive swimming tests was decreased greatly by total body irradiation with 600 r of x-rays. Animals which survived nine weeks or longer after irradiation regained their initial performance ability. The stress of repeated phycisal performance caused a 50% mortality among irradiated swimmers while 100% of irradiated non-swimming animals survived. Some correlative alterations in body weight and test performance are analyzed.

519 Pharmacological reactions of sera and drugs irradiated with roentgen rays of varying wavelength. David I. Macht and Marcus Ostro. Am. J. Roentgenol. Radium Therapy 61, 534-42 (1949) Apr.

The effects of roentgen rays of varying lengths on the pharmacological properties of blood sera and drugs are described. The growth and elongation of the straight single roots of lupinus albus seedlings, and other zoopharmacological, phytopharmacological, and biochemical methods were used to detect the effects of the rays. Roentgen dosages of the sera of patients with leprosy, pemphigus vulgaris, hemophilia, trachoma, and several types of psychoses were usually 100 r over periods of 4-85 min. Various filters were used to change the lengths of the rays. Specific effects occurred with some types of wavelength radiation, the most prominent being the reduction of the toxic properties of the hemophilia, psychotic, and pemphigus sera. The sera of trachoma and leprosy patients were not affected. Apparently there was a qualitative difference in the biological effects of the rays taking place. Irradiation effects on such drugs as digitalis, digitoxin, the venom of Crotalus atrox, the neurotoxin of Naja tripudians, and solutions of penicillin and streptomycin are also discussed. Favorable therapeutic results have been obtained in the treatment of hemophilia and pemphigus patients, through deep penetrating radiations. It is noted that the interesting experiments warrant further investigations. 20 references. 15 tables.

520 Plant injury from P^{32}. G. Dion, C. F. Bedford, R. J. St. Arnaud, and J. W. T. Spinks. Nature 163, 906-907(1949) June 11 (Letter to the editor).

An experiment is described in which two rows of Saskatchewan wheat were treated with inactive fertilizer and one row with fertilizer containing radioactive phosphorus, P^{32}, for the purpose of studying the possible injury effects of the tracer on the plants. The fertilizer was applied so as to give 12, 24, and 48 lb of P_2O_5 per acre. Two dilutions of the tracer were used, 26 mc and 260 mc per gram of phosphorus. The data are listed in two tables included in this article. The results indicate that there are no harmful effects from the radioactive phosphorus at the levels administered in this experiment.

BIOLOGY AND MEDICINE (continued)

521 Quarterly research report, School of Aviation Medicine, United States Air Force, January 1 to March 31, 1949.

Among the research projects currently being conducted at the USAF School of Aviation Medicine at Randolph Field, Texas, and described in the Quarterly Research Report of January 1 to March 31, 1949, are the following: The Antibody Response of Animals Exposed to x-radiation, by Roland B. Mitchell and Gale H. Keyes; Bone Marrow Implants in the Treatment of Radiation Sickness, by John M. Talbot, John E. Pickering, and Everett O. Richey.

522 Some biochemical effects of ionizing radiations. Samuel Schwartz. Bull. Univ. Minn. Hos. and Minn. Med. Found. 20, 617-654(1949) June 3.

From experimental studies and from a survey of the literature, the following conclusions have been drawn: The most striking biochemical changes found after excessive radiation exposure in humans were (1) an increase in urine "corticosteroid-like substances in all of the 5 individuals studied, (2) a prolonged increase in the "adenosine triphosphate" phosphorous in the peripheral white blood cells of a patient given total body x-ray for the treatment of a metastasizing parotid tumor, (3) pronounced terminal increases in urinary coproporphyrin excretion in 3 patients who died within a few weeks after heavy exposure to external radiations, and (4) increased excretion of "urorosein fraction" pigments in severely ill patients given large doses of total body x-irradiation. Other changes found included a shift to the left in the Arneth count, and an increase in erythrocyte sedimentation rate. The chief changes found in experimental animals include the following: (1) a drop in urinary coproporphyrin excretion followed by a terminal rise, (2) an increased excretion of fecal urobilinogen, indicative of increased red cell destruction, (3) an increased terminal excretion of kynurenic acid, (4) an increased excretion of uric acid and a decreased uricolytic index, and (5) terminal increases in excretion of urinary urobilinogen.

More fundamental information is needed on the nature of both early and late biochemical effects of radiation. Studies of physiologically important oxidation-reduction phenomena, and protein and enzyme effects seem especially promising.

523 The effect of zirconium and sodium citrate on the distribution and excretion of simultaneously injected thorium and radiostrontium. Jack Schubert and Herschel Wallace, Jr. AECD-2621, Apr. 19, 1949. Decl. June 8, 1949. 24p.

The distribution and daily excretion of tracer levels of injected thorium and strontium were studied in rats receiving zirconium or sodium citrate intraperitoneally 1/2 hr after the administration of the radio-elements ("early" treated) or 3 days later ("late" treated). One group of rats received no other treatment. In contrast to previous studies on plutonium and yttrium, zirconium citrate had no specific effect on Th or Sr metabolism other than that associated with the citrate part of the molecule. The early administration of zirconium or sodium citrate resulted in about a 3-fold increase in the urinary excretion of Th and a 2-fold increase in the urinary excretion of Sr during the following 24 hr. No effect on the fecal excretion was found. The Th concentration in the liver, mensenteric lymph node, pancreas, and spleen were markedly reduced as a result of early sodium citrate administration. No significant changes in the metabolism of Th or Sr were found in the late treated group. The deposition of Th/g was highest in the soft tissues, particularly in the liver, while Sr accumulated mainly in the skeleton. The results indicate that cationic radioelements are fixed in bone by at least three different mechanisms. An interpretation of the results in terms of ion exchange, surface absorption, and complex ion formation is presented.

BIOLOGY AND MEDICINE (continued)

524 Deposition of representative radioactive alkaline earth and rare earth elements in the skeletal tissues of the rat. C. W. Asling, Mrs. D. A. Heller, D. H. Copp, and J. G. Hamilton. AECU-254, nd. 1p.

This document is in abstract form; it is reproduced below in its entirety.

Radioautographs of sections through the costochondral junction of young normal and phosphorus deficient rats were compared with undecalcified silver-stained sections to determine any differences which might exist in deposition of carrier-free radiostrontium (Sr^{90}) in bone, osteoid, hyaline cartilage, and calcified cartilage. The rats were sacrificed 1 and 72 hours after intraperitoneal administration of the radioelement. Radiostrontium was found in the compact bone of both normal and deficient rats as well as in the spongy bone of normal controls but not in the osteoid of the deficient animals. The distribution and degree of deposition was comparable at 1 and 72 hours. In both control and deficient rats radiostrontium was demonstrated in the calcified cartilage but not in the hyaline cartilage. The degree of deposition approached that of the cortical bone of the same sections. The distribution of promethium (element 61) in normal adult rats at 96 hours differs remarkably from that of strontium. The promethium was observed in the region of periosteum, endosteum, and perichondrium and not in cortical bone, hyaline cartilage, or calcified cartilage.

525 The biosynthesis of radioactive starch. Martin Gibbs, Rosemary Dumrose, and Frances Acher. AECU-283, nd. 4p. Proposed for publication in Arch. Biochem.

A method has been described for the isolation of C^{14}-labeled starch from bean leaves exposed to an atmosphere of radioactive carbon dioxide. The starch was extracted from the leaves with dilute perchloric acid. The extracted starch was precipitated with 20% NaCl solution and iodine-potassium iodide reagent. 5 g of leaves yielded 10 mg of starch with a specific activity of 12.4 mc/mg.

526 Report on qualitative specifications for animal laboratories for experimental work with radioactive materials. Arthur D. Little, Inc. AECU-298, Dec. 8, 1948. 94p.

Available information pertinent to the construction of animal (rats, mice, guinea pigs, rabbits, and dogs) laboratories designed for experimental work with radioactive materials has been collected. Recommendations on layout, materials of construction, technique of operation and precautions are made on a basis of this information. 6 references.

527 C^{14} uniformly labeled sucrose. Martin Gibbs, Rosemary Dumrose, and Frances Acher. AECU-329, nd. 8p.

A carbohydrate depleted leaf was allowed to photosynthesize for 24 hours in the presence of $C^{14}O_2$. After photosynthesis, the leaf was killed and extracted with 80% alcohol. The resulting solution was extracted with ether, then passed through ion exchange columns to remove ether insoluble organic acids and amino acids. The solution passing through the columns contained a mixture of sucrose, fructose, and glucose. The monosaccharides were fermented out with Saccharomyces globosus. The yeast was centrifuged off and the supernatant sugar solution was again passed through the columns. The solution was concentrated and the sucrose was crystallized by the addition of absolute alcohol.

528 Distribution of labeled carbon in plant sugars after a short period of photosynthesis in $C^{14}O_2$. Martin Gibbs. AECU-330, nd. 2p.

It has been found that sugars isolated from plants which have photosynthesized in $C^{14}O_2$ for 1 hour, 2 hours, and 24 hours have radioactive carbon in all positions; however, in the 1- and 2-hour periods of photosynthesis in barley the distribution of the label was opposite to that previously reported elsewhere (Aronoff, et al, J. Biol. Chem. 169, 459(1947)). The greatest percentage of the label was in positions 1 and 6 while positions 3 and 4 contained the smallest percentage of radioactive carbon.

BIOLOGY AND MEDICINE (continued)

529 Biological synthesis of radioactive silk. Paul C. Zamecnik, Robert B. Loftfield, Mary L. Stephenson, and Carroll M. Williams. Science 109, 624-6(1949) June 24.

An experiment designed to test the ability of the giant silkworm, Platysamia cecropia, to incorporate radioactive glycine and alanine into the protein, fibroin, of the silk it synthesizes, is described. A total of 27,000 counts per minute was observed in the silkworm after an injection of 0.05 cc of a mixture of radioactive glycine and alanine into its body cavity. The injection contained 0.013 mg of C^{14}-glycine and 0.02 mg C^{14}-alanine. A similar injection of 0.04 mg of alanine in 0.05 cc of solution was administered to a second animal. Silk strips from cocoons spun by these animals exhibited radioactivity which was shown by a procedure described to be present in the α-carboxyl group of some amino acid associated with the silk fibers. Further tests proved that these amino acids were incorporated into the peptide chain structure of the fibroin itself. A protein synthesis in vitro was then attempted by the incubation of freshly dissected silkworm glands in a Warburg apparatus containing a medium and 0.37 mg of C^{14}-glycine. The results did not definitely confirm a true protein synthesis.

530 Cutaneous granuloma from accidental contamination with beryllium phosphors. A. D. Nichol and Rafael Dominguez. J. Am. Med. Assoc. 140, 855-60(1949) July 9.

A report of two cases of cutaneous granuloma arising from accidental contaminations with beryllium phosphor is presented. The beryllium content in the phosphor was about 1.5% by weight. The author suggests that cases developing as a result of the low concentration of beryllium seem to prove that the percentage content is a minor factor in the occurrence of the disease. Chronic fibrosis and supperation, rales, shortness of breath, paroxysmal orthopnea and progressive loss of weight are some of the symptoms of the disease, which may involve the lungs as well as the skin. The results of continued rest and other methods of therapy in the first case discussed resulted in no improvement. Surgical excisions of the infected skin areas in both cases showed the presence of diffuse granulomas of the sarcoid type. There was some improvement in the second patient after the excisions. The conclusion is that chronic persistent granulomatous inflammations of the skin with ulcerations may follow accidental lacerations caused by florescent bulbs containing beryllium. The histological appearance of these skin granulomas is similar to that found in the lung of fatal cases of pulmonary granulomatosis occurring in beryllium workers.

531 The failure of 2, 3 dithiopropanol (BAL) to affect acute, systemic uranium poisoning. W. F. Neuman and R. P. Allen. J. Pharmacol. Exptl. Therap. 96, 95-8(1949) May.

The results of experiments to test the ability of BAL (2, 3 dithiopropanol) to neutralize the effects of uranium posioning are described. An experiment was performed on albino rats (which had been systematically poisoned with 3.0 mg/kg of HgCL) and proved the efficacy of BAL to relieve the toxic effects of Hg compounds as much as 30 minutes after their administration to rats. BAL was also assayed against three representative uranium compounds, hexavalent uranyl nitrate ($UO_2(NO_3)_2 \cdot 6H_2O$), uranyl flouride (UO_2F_2) and tetravalent uranium tetrachloride (UCl_4). Sixty rats were given 3.0 mg U/kg, intraperitoneally as a 0.63% aqueous solution of uranyl nitrate hexahydrate. Another experiment was conducted with uranyl flouride at a solution concentration of 0.324% with 2.5 mg U/kg. Both of these experiments made use of a 1.24% solution of BAL as a means of reducing the rat mortality. The results show that the BAL produced no appreciable reduction in the mortality rate in either of the series. The negative results were taken as confirmatory evidence that uranium exerts its toxic effects primarily by some other means than a combination of the -SH groups, a toxification process that BAL is capable of reducing.

BIOLOGY AND MEDICINE (continued)

532 The rutin treatment of osler's disease (hereditary hemorrhagic telangiectasis). N. Markoff. Schweiz. med. Wochschr. 40, 984-6(1948) Oct. (in German).

The use of rutin in the treatment of Osler's disease, the therapeutic methods, dosages and other data are given. Tables are included which outline the blood cell counts at different points in the therapy. Observations and investigations are over a 6-month period. The average daily dose of rutin amounts to 150 mg, delivered in 3 doses of 50 mg each. A smaller amount is not effective. If sulfonamides are used in connection with this therapy the rutin dosages must be raised to 450 mg per day. The rutin effect begins after only a few days treatment and stops with continued doses at the same level. The capillary fragility becomes immeasurable, and the Gothlin index reaches normal. The first extensive observations were to show whether, with the above continued treatment, the doses of the remedy could be gradually reduced to a point below the control of the petechial indices. The observations confirm the rather meager information contained in American articles concerning the favorable effects of rutin on this disease.

533 Use of geiger counter for quantitative estimation of isotopes in histological sections. Geoffrey H. Bourne. Nature 163, 923(1949) June 11.

A method of obtaining quantitative estimations of radioactive isotopes in histological sections through the use of a Geiger counter is presented. The conctruction of this apparatus is given in detail in 4 figures. It consists mainly of a copper plate attachment to the fixed part of a microscope stage under which is the movable part of the stage and the histological slide. The slide is scanned by means of a small hole in the metal plate to which is connected a Geiger-Müller counter through a lead funnel; readings of different parts of the slide can be made directly. A description is given of the varaitions in counts in a series of runs on a typical slide. It is concluded that this technique may be of use in studying the distribution of radioactivity in adult and embryological tissues.

534 Health physics division instrument manual. D. M. Davis. AECU-299, June 7, 1949. 116p.

This manual is concerned with the types of portable survey instruments used at Oak Ridge National Laboratory and what they are designed to do. It includes a working knowledge of the types of radiation encountered at Oak Ridge National Laboratory, tolerances for different types of radiation, instruments used to measure the various types of radiation, brief calibration procedures, what the instruments are designed to do, some of the common malfunctions of the instruments, and methods used in counting air and smear samples.

535 Concerning the use of potassium iodide as a protective measure to those persons who are exposed to radioiodine in the atmosphere. Charles H. Perry. AECU-306, June 3, 1949. 7p.

A procedure states that in those cases where persons are exposed to radioiodine in the atmosphere and it is deemed advisable to give them daily doses of 100 mg of potassium iodide to act as a diluent to the absorbed radioiodine, it is mandatory that those persons be first examined by a physician. This procedure is to satisfy the legal aspect of the administration of the iodide as well as to prevent the use of this dosage to those persons who are supersensitive to iodide, have or have had active tuberculosis or an arrested case, or have impaired kidney function.

536 Internal radiation hazards in industry from the use of polonium in static eliminator devices. Fred A. Bryan and Louis B. Silverman. AECU-343, Apr. 11, 1949. 16p.

The use of radioactive materials as static eliminators has been described. Although polonium is an energetic alpha particle emitter and, therefore, an excellent static eliminator, it has many serious disadvantages. Such devices produce industrial inhalation hazards by contamination of the air with fine particles containing radioactive polonium. Also the ingestion of minute quantities of polonium may cause serious injury. The hazard here is primarily by contamination of the hands. Impure polonium containing radiolead (Pb^{210}) is even more injurious. Therefore, it is recommended that all plants, companies and individuals engaged in the production, investigation, and use of such radioactive substances and devices be made cognizant of the dangers from internal radiation injury.

BIOLOGY AND MEDICINE (continued)

537 Atomic danger from the radiation point of view. Lucien Mallet. J. Radiol. Electrol. 29, 631-4(1948) (in French).

General information is given on lethal and pathological effects of the atomic bomb, the main sources being American publications on Hiroshima, Nagasaki, and Bikini (no closer data on references are given). The effects are discussed under several headings. Detonation wave: no biological reactions are mentioned. Heat radiation: up to several hundred meters from the center of the explosion, all living beings, if not protected, are destroyed; the burning effects upon the skin are felt up to 3,500 meters. Visible and ultra-violet radiations: no precise facts are known. Neutrons and β-particles: the range of the neutrons is probably about 500 m; that of the β-particles about 10 m; however, owing to the high initial kinetic energy, the ranges may differ considerably from the values given. γ-radiation: to these are due the majority of casualties and of observed biological effects; the energy limit is probably 3-4 Mev; the rate of casualties resulting in death is 20%; at a distance 1,000-1,200 m from the explosion center the mortality is 50%; beyond 1,500 m death is rare. In the zone between 500 and 750 m, persons who were protected from the detonation wave and the heat, but had absorbed penetrating radiations, died within a week (bloody diarrhea, hematemesis); between 750 and 1,000 m, death occurred 3-5 weeks after the explosion (buccal ulcers, leucopenia, cutaneous hemorrhages, alterations of the bone medulla). Among non-mortal cases were temporary male sterility, miscarriages, loss of hair. The last of the explosion effects enumerated here is the remaining radioactivity due to scattered fission products and to induced radioactivity; this was found weak in Hiroshima, but rather dangerously high in New Mexico. The accumulated fission products from the uranium piles may be used as a powerful weapon of war, in the form of dust spread over the enemy's cities.

538 Bibliography on radiation protection. H. H. Goldsmith. Nucleonics 4, 62-9(1949) June (See also Nuclear Science Abstracts 2-235).

This bibliography includes several hundred references under the following general headings: (1) reviews, (2) general biological effects of radiations, (3) blood changes due to radiation, (4) radiation sickness, (5) atomic bomb effects, (6) tolerances doses and dosage measurements, (7) radiation exposure monitoring, (8) health protection measures, (9) dust monitoring and hazards, and (10) laboratory designs. (To appear as part of a report from the Committee on Nuclear Science of the National Research Council. A more comprehensive bibliography on this subject is being compiled by the author for the United Nations as "An International Bibliography on Atomic Energy. Vol. II-Scientific aspects.")

539 Concrete as a protective barrier for γ-rays from radium. Harold O. Wyckoff and Robert J. Kennedy. J. Research. Natl. Bur. Standards 42, 431-5(1949) May.

Although lead is usually suggested as the most suitable material for barriers against γ-radiation from radium, concrete is often more economical to use for shielding in high-energy x-ray installations. It has been suggested that concrete might also be useful for shielding in γ-radiation installations. The necessary attenuation curves have been obtained for radium and are given in tabular form. The barrier requirements, assuming a permissible dosage rate of 0.3 r/48-hr work week, have been calculated and tabulated, also.

540 Hazards to physicians, patients, nurses, and others from use of radioactive isotopes. W. Edward Chamberlain, R. R. Newell, Lauriston Taylor, and Harold Wyckoff. Am J. Roentgenol. Radium Therapy 61, 726-8(1949) May.

A discussion of the problem of radiation injury is presented. The authors stress the fact that there is no antidote for radiation injury, so particular caution must be practiced on the part of the operator to prevent injury to the patient and to himself. The various types of external and internal irradiation are also mentioned. Patients' hazards mostly arise from errors by the physicians in calculation intensity doses. Wet and dry isotopic-containing wastes have to be disposed of by collection and isolation (deep burial, etc.) rather than dilution and distribution, because of the ability of some algae and other plant forms for re-concentrating these materials. A table is included which lists the hazards from radioactive isotopes, which may be used as a guide for the adequate control of these materials by physicians.

BIOLOGY AND MEDICINE (continued)

541 Introductory manual on the control of health hazards from radioactive materials, issue no. 2. Atomic Energy Research Establishment. Jan. 1949. 15p. (NP-921).

The manual discusses the nature of the hazards and the type of precautions which must be taken in working with radioactive materials. The topics discussed are of the general nature of radiation hazards, maximum permissible dose of radiation, the measurement of radiation intensity and dosage, safe and hazardous amounts of radioactive material, laboratory facilities for working with radioactive materials, protective clothing and devices, handling of radioactive isotopes, eating and cleanliness, storage of radioactive materials, disposal of active waste, and transport of active material. Appendexes on units of radioactivity and radiobiological dose, radiation monitors, and shield thickness for laboratory sources are included.

542 Radiation hazards and industrial hygiene. Howard L. Andrews. Ind. Hyg. Newsletter 9, 4-6(1949) July.

A general discussion of radiation hazards and the problems of industrial hygiene is presented. Such topics as high-energy radiations, the dangerous types of rays, some biological effects — malaise and lowered leukocyte counts, and the units of measurement of the rays are treated briefly in separate paragraphs. It is stated that radiation hazards from external sources can be reduced by reducing the time of exposure to the rays, increasing the distance from the radiation source, and by using shielding methods.

543 Radioactivity of dust. C. Jěch. Nature 163, 570(1949) April 9 (Letter to the editor).

The dust from air containing 1.5×10^{11} curie/cc of radon was deposited in the form of a dust spot on a glass plate, by aspirating 90 cc of this air in an Owens-Běhounek dust-counter. After 10 minutes the glass was pressed on the emulsion of an Ilford Nuclear Research plate C-1 and left there for an hour. Further experiments have been carried out to decide whether the atoms of the active deposit settle on the glass directly or through the intermediary of the dust particles. These results obtained suggest that the deposition on glass of the atoms of the active deposit from radon is due to the presence of the dust in the air; that is, these atoms are at least partially, if not entirely, absorbed on the dust particles.

544 Recommendations of the British x-ray and radium protection committee, seventh revised report. British X-Ray and Radium Protection Committee. Oct., 1948. 16p. (NP-922).

Protective measures recommended are included under the following sections: working hours and other conditions, general x-ray and radium recommendations, x-ray protective recommendations, electrical precautions in x-ray rooms, film storage recommendations, x-rays for industrial and research purposes, radium protective recommendations, electrical precautions for electromedical apparatus, and ultra-violet therapy.

545 Relation of exit dose and other dosage factors to roentgen injuries. June C. Shafer, Carl B. Braestrup, and Jerome K. Fisher. Arch. Dermatol. Syphilol. 59, 472-83 (1949) Apr.

One hundred and sixty cases of chronic radiodermatitis, 85 occurring after the treatment of benign dermatoses, have been reviewed with reference to the exit dose as a factor in the production of chronic roentgen injuries. Fifty-six patients were treated by irradiation, usually over prolonged periods of time, for conditions in which superficial therapy to opposing surfaces is still frequently used. Radiodermatitis was present frequently in this group on the middle part of the face and the extremities, where the exit dose is high, and it may have been an additional factor in the production of radiation damage to the skin. Tables are included enabling the dermatologist to take into account the exit and back-scatter factors in roentgentherapy of superficial dermatoses involving the face and extremities.

BIOLOGY AND MEDICINE (continued)

546 Shielding of syringes used for injecting radioactive solutions. H. C. Dudley, J. F. Bronson, and R. O. Taylor. Science 110, 16-17(1949) July 1.

The details of the construction of two types of shields for use with syringes, when administering radioactive substances, are presented. One type is a lucite tube, and the other consists of an aluminum tube filled with a lead alloy. These shields have been used in the study of the biological effects of radiogallium (Ga^{72}), which has an unusually energetic spectrum. Difficulties arise in the use of these shields because of their weight and size.

547 Species of Aloe (other than Aloe vera) in the treatment of roentgen dermatitis. L. J. A. Loewenthal. J. Investigative Dermatol. 12, 295-8(1949) May.

Two species of the Aloe plant, Aloe arborescens and Aloe mutabilis, are presented as having beneficial results in the treatment of roentgen dermatitis comparable to those of Aloe vera. Two cases of radiation dermatitis treatment are included. 10 references.

548 The ABC's of roentgen technique. H. Vogler and E. Wagner. George Thieme, Leipzig, 1948. 708p. (in German).

This reference book on roentgen technique contains a large amount of curves and table material and is of use to physicains, assistants, and technicians.

549 The Bellevue method for the treatment of carcinoma of the cervix. Ira I. Kaplan. Med. Record 162, 9-13(1949) June.

The Bellevue method described here for the treatment of carcinoma of the cervix is based primarily upon the method founded originally by the Curie Institute of Paris, and consists of a combination of x-ray and radium therapy. For clinical purposes all cervical lesions are divided into three types: the ulcerated, excavated type, the proliferative type, and the infiltrating type. The x-ray therapy is administered to the pelvis through the multiple field plan, which involves doses of 200-300 r until 2,000-4,000 r is reached, or the single field plan, which involves doses of 300 r until 2,000-3,000 r has been given to each area. The protracted method, described, is occasionally used and radium-pack doses of 5,000-10,000 mg-hr per treatment daily are also given, as well as radium sound insertions. Doses for bulky cervix tumors, and cervical stump malignancy are included. In conclusion, it is stated that 25 years of experience permits the authors to offer this method as a most efficient and applicable method of radiation.

550 Cancer: radiations, virus, environment. (Vol. II.) J. Maisin. Casterman, Paris, France. 1949. 306p.

This book is a critical review of the literature on the relationship of radiations, viruses, and environment to cancer. A discussion is presented of the effects of cutaneous contact with x-rays, inhalation of radioactive substances, and ingestion of radioactive substances, together with a variety of other related topics. The author believes that cancerization by rays, whether external or internal, is the result of mutation of normal cells into neoplastic cells. One important characteristic of this mutation is the long period of latency experienced (in man, 10-20 years). He expresses great interest in the possible long-term effects to the descendants of the people irradiated at Hiroshima and Nagasaki in 1945. The author hopes for the discovery of a "penicillin or sulfonamide" to combat the cancer cells arising from these and other cancerogenic agents.

551 Carcinoma of the breast; a 15-year survey of 205 cases. Thomas Harrold and Eugenia Etheridge. J. Med. Assoc. Georgia 38, 245-9(1949) June.

A consecutive series of 205 cases of carcinoma of the breast treated between 1931 and 1942, inclusive, has been reviewed and analyzed. The uses of radiotherapy and mastectomy are discussed. No dosage levels for the radiotherapy are given. Most of the cases reviewed were third and fourth stage types. The conclusion is that pre-operative x-ray therapy is of definite value when axillary glands are involved, or when the diseases are of borderline operability in other aspects.

BIOLOGY AND MEDICINE (continued)

552 Carcinoma of the rectum and anal canal. Treatment with very high voltage X-ray therapy. I. G. Williams. Brit. J. Surg. 36, 376-81(1949) Apr.

A discussion of the various types of treatment of carcinoma of the rectum and of the anal canal is presented. The treatment by x-rays has been abandoned in Great Britain, according to the author, and radium therapy is only used for tumors which have penetrated less than 2 cm from the radium source. The reasons for this change are given: the tumor cells are scarcely more radio-sensitive than the normal mucosa; uniform irradiation is difficult; good access is difficult; and, gross sepsis is present in these cases. Out of a total of 49 cases treated at St. Bartholomew's Hospital, only 1 case survived 5 years. Changes and reactions are discussed in connection with supervoltage x-ray therapy of 192 cases of carcinoma of the rectum and 25 cases of carcinoma of the anus. The reactions included an early general reaction, blood changes, bladder irritations, late bowel irritations and pain, fistulas, fibroses, and necroses. In conclusion it is stated that operable carcinoma should be treated by surgery, even in advanced cases with metastases. Radiotherapy plays a definite role in the treatment and management of carcinoma of the rectum; the increased depth-dose and the greater accuracy of the million-volt x-rays makes this type of therapy superior to the deep x-ray therapy previously used. Radio therapy is not advised as a pre-operative procedure because of the risk of necrotic changes due to the heavy irradiations. 10 references.

553 Concentrated roentgen therapy of cervical tuberculous lymphadenitis. Isadore Lampe, Clarence P. Chrest, and Donald A. Koch. Am. J. Med. Sci. 217, 632-6(1949) June.

The advantages and results of a technique of concentrated irradiation of cervical tuberculosis lymphadenitis cases are presented. The results of 37 cases in which this type of therapy was used are contrasted with the results obtained through the use of streptomycin. The radiation technique consists in using radiations generated at 200 kv, filtered through 0.5 mm Cu and 1.0 mm Al, at a target distance of 50 cm, and at a rate of about 50 r/min. The treatment is given daily and consists of 200 r (in air) to one field, for 4 or 5 days. Smaller doses are given to children and debilitated adults. Usually the total dosage is 800-1,000 r per field; occasionally the patients receive a second dose. The reactions from the irradiations are few; no late cutaneous damage has been noticed. The results show that complete regression of the diseased nodes and healing of the sinuses occurred in 84% of the 37 cases; in about 20% of these, a second course of irradiation was necessary to achieve this result. It is concluded that, for the present at least, radiation therapy must be considered superior to streptomycin therapy, which should be reserved only for cases which do not react favorably to the irradiation therapy.

554 Concerning the multiple possibilities for the application of a long-lasting artificial radioactive isotope Co^{60}, in liquid form, for the radiation therapy of malignant tumors. J. H. Müller. Schweiz. med. Wochschr. 79, 547-51(1949) June 18 (in German).

The author describes a new technique for the radiotherapeutic utilizztion of long-living artificial radioactive isotopes. Radio-cobalt (Co^{60}, half-life 5.3y) is employed in liquid form (radio-cobalt chlorine solution, with sodium iodine added for x-ray contrast). The radioactive solutions are measured by means of an ionization chamber, in order to determine the effective radium-equivalency. The spacial distribution of γ-radiation is also determined by auto-radiographs. The clinical application of radio-cobalt solutions is performed by means of suitable rubber balloons, a procedure made possible by the fact that Co^{60} emits a practically monochromatic γ-radiation of high energy (1,2 Mev) and a soft β-radiation (0.3 Mev). which is readily absorbed by thin material layers. The author demonstrates that it is possible to introduce such empty rubber balloons, mounted on a catheter, into the urinary bladder, and then fill these containers, "in situ," with the radio-cobalt solution. This filling method increases the radio-therapeutic possibilities in severe cases of cancer of the bladder. Other regions in the human organism are suitable for radioactive applications of this kind.

BIOLOGY AND MEDICINE (continued)

555 Current trends in diagnosis and treatment of cervical cancer. George L. Hoffman, Jr. Am. J. Med. Sci. 217, 681-9(1949) June.

A review of the diagnosis and treatment of cervical cancer is presented in which intra-epithelial carcinoma is discussed as it relates to invasive cancer. Irradiation therapy, on the basis of 5-year survival rates, is concluded to be the treatment of choice for most patients with cervical cancer. Surgery is used when the carcinomas are radio-resistant. It is stated that individualized therapy is the best method of successfully treating the largest number of cases. 87 references.

556 The development of gynecological radiation therapy. Georg Athanassiu. Med. Klin. (Munich) 44, 289-92(1949) Mar. 11 (in German).

A review is made of the development of gynecological radiation therapy covering the period from 1902 up to the present time. Present techniques include a limited field of radiation and the employment of deeply-penetrating rays. Further development is expected in regard to the number and amount of the doses and the perfection of intra-vaginal radiations.

557 Early conduction deafness treated by radium. Samuel Brown. Bull. of Iowa & Ill. Central District Med. Assoc. 15, No. 4, 13 continued on 24-25(1949) May.

The treatment of conduction deafness in children through the use of radium applicators is effective since lymphoid tissue, which is responsible for the condition, is very sensitive to small amounts of radiation. The radium, 50 mg., is applied in a monel-metal applicator, and is passed along the floor of the nasal cavity and placed in direct contact with the lymphoid tissue around the tubal orifice. Twelve and one-half minutes is the usual radiation time for each side of the postnasal space, and 3 treatments about 2 or 3 weeks apart are usually administered. The radiations stunt the lymphoid tissue growth. Very good results have been obtained with this therapy.

558 Endothelioma of bone. Bradley L. Coley, Norman L. Higinbotham, and Lemuel Bowden. Ann. Surg. 128, 533-60(1948) Sept.

The diagnosis, clinical manifestations, etiology, anatomic site, and treatment of endothelioma of the bone are presented. Surgery, roentgen and radium therapy, and toxins are used as therapeutic agents in the treatment of the disease. In the series under discussion, 69 patients received roentgen therapy for the primary tumor. The variation is great in the amount and type of radiation therapy since these cases cover a long period of time; only one patient received 1,000 kv therapy. Radium therapy was administered in 32 cases. The results are uniformly poor since only 3 out of 73 cases survived 5 years or more, regardless of the therapeutic method employed. Palliation for a period of 1-3 years can be obtained through the use of roentgen therapy. 86 references. (This article was read before the American Surgical Association, Quebec, Canada, May 28, 1948).

559 Functional radiotherapy and novocaine infiltration. J. Gouin and Vitrolles. J. Radiol. Electrol. 30, 126-7(1949) (in French).

It is found that periarterial and catenary infiltrations of non-adrenalined novocaine determine reactions that are analogous to those caused both by functional radiotherapy and by functional surgery, when applied in the same regions. Since two of these methods, viz. novocaine infiltrations and functional surgery, act directly upon the sympathetic, it should be inferred that in the third method, the x-ray therapy, there is a similar action upon the organism through the intermediary of the sympathetic.

BIOLOGY AND MEDICINE (continued)

560 Irradiation in cancer of the tongue. Charlotte P. Donlan. Am. J. Roentgenol. Radium Therapy 60, 511-21(1948) Oct.

Eighty-three unselected, consecutive patients with carcinoma of the tongue are reviewed. The group had an overall 5-year survival rate of 30.9%. The type of irradiation used in treating the primary lesions is given in detail and the management of metastases is discussed. The tumor dose to the tongue for each patient is given in lists which are divided according to the following system: operable tongue lesions, borderline tongue lesions, inoperable tongue lesions, (these three are treated with radium and roentgen ray therapy) and tongue lesions treated only with roentgen irradiation. The daily average dose was 200-250 r in air and the duration of the treatment was 4-6 weeks. When roentgen therapy alone was used, the aim was to deliver a total tumor dose of 5,000-6,000 r. When radium needles were used an attempt was made to deliver 8,000 γ-roentgens or more to the tongue. The longest duration of symptoms was in the operable group. It is stated that it is apparent that the size and extent of the lesion as well as the location are the most important factors in determining the prognosis of the case regardless of the tumor dose given. In the cases of metastiatic involvment, the author favors neck dissection because of the frequently heavy damage to the surrounding regions when irradiation therapy is invoked. 26 references.

561 National cancer conference. Cancer News 3, 1-9(1949) May.

The National Cancer Conference was held in Memphis, Tennessee, on February 25, 26, and 27, 1949. In the course of the panel discussions, the following topics were included: the treatment of lymphoblastomas, head and neck cancers, lung cancers and soft part tumors; the experimental production of bone tumors by irradiation and radioactive elements; the diagnosis of intracranial cancer through radioactive isotopes, and the use of radium, radioactive isotopes and roentgen rays as therapy; and, the problems of protection against nuclear energy and beryllium.

562 Nonsurgical treatment in hypophyseo-hypothalamic diseases. R. Luft. Nord. Med. 38, No. 22 1065-72(1948)(in Norwegian).

The results of treatment of hypophyseo-hypothalamic diseases are discussed, together with some important functions of the pituitary hormones. Eight cases of diabetes insipidus are described, in which x-ray therapy was employed, in combination with posterior pituitary hormone treatment. Two cases showed improvement after this therapy. In eight cases of Cushing's syndrome, marked improvement was also noted through the use of x-radiation. In acromegaly, the x-ray therapy is considered the treatment of choice.

563 A note on back-scatter and depth doses for elongated rectangular x-ray fields. D. E. A. Jones. Brit. J. Radiology 22, 342-5(1949) June.

Two families of curves are presented which provide a ready means of correcting for changes in central surface and axial depth doses due to the use of elongated rectangular fields in deep x-ray therapy. The method is based on the scheme of Meredith and Neary for the calculation of x-ray depth doses (Brit. J. Radiology 17, 126(1944)).

564 Observations made in Zürich on parosteal sarcomas. H. R. Schinz and G. Damm. Oncologia 2, 19-42(1949)(in German).

A report of 90 cases of sarcomas of the parosteal soft tissues treated from 1920 to 1946 at the Zürich Radiotherapy Clinic is presented. The sarcomas were round-cell (little differentiated or undifferentiated types), spindle-cell, and polymorph-cell sarcomas, fibrosarcomas, myxosarcomas, and synoviomas, and occurred approximately equally in both sexes, with increasing frequency in old age. The thighs were a very frequent site of the tumors. The therapy consisted of pre-operative x-ray therapy, surgery, and post-operative x-ray therapy. Tumor doses of 6,000 r and 9,500 r are mentioned. Round-cell sarcomas gave the worst results; fibrosarcomas gave the best results. After 10 years, 25% of the patients are alive and symptom free.

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565 Postirradiation osteogenic sarcoma of the nasal bone; a report of two cases. John J. Wolfe and William R. Platt. Cancer 2, 438-46(1949) May.

Two cases of post-irradiation osteogenic sarcoma involving the nasal bones are presented and discussed. The literature lists a total of 62 such cases. In one case presented here roentgen therapy doses of 100 r, 200 r, 200 r, 405 r and 123 r were administered to the patient singly or in series over a period of 17 years. Radium therapy was also given to the patient and consisted of a total of 330 mg-hr at distance 0. A malignancy then developed and was identified as sarcoma of the nasal area. The dosage levels in case two prior to the development of the nasal sarcoma are unknown; but extensive roentgen therapy for acne had been conducted some years before.

566 Precision dosage in interstitial irradiation of cancer of the cervix uteri. James A. Corscaden, S. B. Gusberg, and Charlotte P. Donlan. Am. J. Roentgenol. Radium Therapy 60, 522-34(1948) Oct.

An investigation of the methods of application of interstitial radium needles in cases of cancer of the cervix uteri is presented. Various patterns were tried and are described here, and a method was finally arrived at which, due to the configuration of the needles, seems to offer a lethal dose of 7,000 tissue roentgens or more to all the vital parts. To the cervical mass, 11,000 γ-roentgens are delivered by this new method; to the paracervical region the method delivers 14,346.7 γ-roentgens; the extreme lateral parametrium receives 10,803.1 γ-roentgens. The needles lie 1.0-1.5 cm apart in the mass irradiated. One conclusion is that the dosage should be expressed in terms of the amount of radiation reaching the various points at which it is aimed. Radium dosage expressed in milligram-hours and roentgen-ray dosage expressed in roentgens delivered to the skin are only partially informative. 16 references.

567 The present status of the treatment of thyrotoxicosis. William H. Beierwaltes. Practitioner 972, 486-95(1949) June.

A summary of the methods of treatment of thyrotoxicosis is presented in which radioactive iodine and the products derived from thiourea are noted as being the most important. A comparison is made between propyluracil therapy and subtotal thyroidectomy and the uses of iodine and radio-iodine as thyroid cures are discussed. Complications connected with radio-iodine therapy such as nephrosis, parathyroprivia, irradiation of the foetus and ovaries, and pulmonary fibrosis and carcinoma are noted. 11 references.

568 The problem of carcinoma of the cervix. S. Paul Perry and W. Dan Haden, Jr. Guthrie Clinic Bull. 19, 48-55(1949) July.

A discussion of the problem of carcinoma of the cervix is presented in which statistics of the 5-year mortality rates compiled by various operators are included. The authors' method of therapy is a radiation course consisting of 8,000 r in air, delivered from a distance of 50 cm to four pelvic portals. A 200 kv machine is used with a 1 mm Cu filter. This is followed in 2-3 weeks by intracavitary radium therapy, of 1,500-8,000 mg-hr if the patient is able to withstand the treatment. The survival rate on 115 cases treated in this manner is 23% after five years. The overall average for radiation therapy cases of carcinoma of the cervix is 26%. The authors stress the need for new diagnostic and therapeutic methods for treating these cases. It is thought that the use of radiation therapy by itself is not the ultimate answer to this problem.

569 Radiation therapy for conductive deafness. Harry C. Rosenberger. Arch. Otalaryngol. 49, 504-10(1949) May.

The results of the roentgen therapy of the nasopharynx of 21 patients with conductive deafness are described. The conductive deafness was thought to be the result of tubal blockage by lymphoid tissue. The advantages of roentgen therapy over radium therapy in the treatment of this condition are discussed in detail. The roentgen therapy was conducted at 200 kv, through 0.5 mm Cu and 2 mm Al filters at a target distance of 50 cm. The results show that one-third of the patients who were given roentgen therapy received significant benefit after the standard otologic treatment had proved ineffective.

BIOLOGY AND MEDICINE (continued)

570 Radiation therapy for Wilms' tumor of the kidney. Samuel George Schenck. J. Pediat. 33, 734-8(1948) Dec.

The methods of treatment of Wilms' tumor of the kidney are discussed, and a description is given of the radiation technique used in the cases reported here. Three portals of entry are employed in the radiation technique, and occasionally for a massive lesion six portals are employed. The total dosage varies from 3,600 r to 6,000 r, and treatments are given up to 200 r daily, one portal being treated at a time. The treatment of metastatic lesions is palliative and is similar to the roentgen therapy for the primary lesion. In the chest, radiations of no more than 200 r per day are given for a total of 800-1,200 r for each field. No accurate conclusions can be drawn, states the author, from the inadequate number of cases. It can be noted that the present management of the disease is poor, however, since the mortality rate is almost 100%. From the present knowledge, an adequate course of pre-operative and post-operative radiations to the tumor offers the best possibitities. 17 references.

571 Radioisotopes in cancer diagnosis and therapy. Murry M. Copeland and Charles F. Geschickter. Cancer Bull. 1, 1-4(1948) Nov. Bound in Medical Annals of the District of Columbia 17, (1948) Nov.

A general discussion of the importance of radioisotopes as therapeutic aids in the treatment of certain diseases is presented in which the roles of I^{131}, P^{32}, Mn^{54}, Au^{198}, Na^{24}, Sr^{89} and Ca^{45} are described. Radio-iodine is used in the treatment of hyperthyroid cases. Radio-phosphorus is deposited selectively in bone and in the nuclei of rapidly multiplying cells, and thus is used in cases of certain blood dyscrasias, polycythemia rubra vera, leukopenic myeloid leukemia, and multiple myeloma. The average dose of P^{32} administered is 5-10 mc, and is given in 1-20 cc of solution. About 15% of the polycythemia cases showed definite improvement after this therapy. Manganese and gold in their isotopic forms have been successfully used in the treatment of diseases of the lymphoid system, such as lymphosarcoma. Radio-sodium has also been used extensively for several of the malignant diseases, and radio-strontium has found its application in the treatment of osteogenic sarcoma. It is concluded that despite the clinical application of these radioisotopes, they have not replaced as yet the older forms of radiation therapy.

572 The radioisotopes in medicine. George M. Lyon. Quart. Bull. Northwestern Univ. Med. School 23, 141-52(1949) Summer (See also Nuclear Science Abstract 2-1728).

A summary of the role of the radioisotopes in medicine is presented in which some of the more important technical considerations and methods of application are discussed. Radioisotopes are being employed as therapeutic agents in the treatment of cases of polycythemia rubra vera, chronic leukemia, thyrotoxicosis, metastatic carcinoma of the thryoid, basal cell carcinoma, and birthmarks. Such topics as instrumentation, the effects of radiation on tissues, the role of radioisotopes as tracer elements, tracer techniques, radioautographs, and the selective localization of the radioactive isotopes and their use in facilitating localized external radiations are briefly covered.

573 Radium in treatment of cavernous haemangiomata. C. G. Campbell. Bull. Vancouver Med. Assoc. 24, 331-3(1948) July.

The use of radium interstitially or by contact radiation is described in the therapy of 7 cases of cavernous haemangiomata in children and adults. The treatment doses are individualized and vary from 10 mg-hr to 700 mg-hr in the cases included in this paper. These cases illustrate the excellent results of the treatment and the variety of problems presented by the patients.

BIOLOGY AND MEDICINE (continued)

574 Results of treatment of carcinoma of the ovary with data on the age incidence of this disease. Joseph H. Marks and Martin H. Wittenborg. Surg. Gynecol. Obstet. 87, 541-5 (1948) Nov.

A review of the literature on malignant epitheliomas of the ovary is presented together with the results of the treatment of 76 patients with x-ray therapy. Fourteen of the patients were alive 5 years after treatment, but 3 have since died. Each of the surviving patients has had no less than 1,800 r delivered to each of 4 pelvic portals. Treatments for the group of patients were given at 400 kv and a 50 cm target distance and with a filter composed of 0.9 mm Sn, 0.25 mm Cu, and 1.0 mm Al. The normal daily dose was 300 r to a single port, and treatments were given 6 days a week. The group of patients in whom long-term survival was not secured were frequently benefited palliatively by the radiations. The age incidence is discussed, and summaries of 14 cases are included. In conclusion, it is stated that x-ray therapy should be given in all cases of carcinoma of the ovaries, and that it is an excellent safeguard post-operatively. The age specific incidence of the disease is unlike that of most other types of carcinomas since it falls after the sixth decade. 10 references.

575 Roentgen ray therapy of basal cell epithelioma by the divided dose technique. Francis A. Ellis and Maurice Sullivan. Mississippi Valley Med. J. 70, 212-4(1948) Nov.

The development of x-ray therapy application by the divided dose method is presented together with the results from two different series of treatments. The first technique involved the treatment of 167 cases of basal cell epitheliomas with five divided doses of 600 r, employing 0.5-1.0 cm aluminum filtrations. The second technique involved the use of similar dosages on 68 patients, but without the aid of any filtration except that inherent to the therapy machine. Epithelitis usually developed several days before the end of the treatments. Mild telangiectasia, almost invisible scarring, and a very few cases of hyperpigmentation and sclerosos were some of the other complications. Of the cases followed up, all those who had small epitheliomas responded satisfactorily. It was also determined through subsequent cases that the technique described here is satisfactory for verruca senilis, but not for extensive prickle cell or baso-prickle cell carcinomas. In selected cases, this method has the advantage of rapid healing and little or no sequelae. 11 references.

576 Roentgen ray treatment of the eye. Herbert S. Alden, Jack W. Jones, and Joseph Rankin. Arch. Dermatol. and Syphilol. 59, 430-4(1949) Apr.

The results of treatment through roentgen eye therapy of more than 300 patients with corneal ulcers are described. The methods of treatment are outlined, most of the patients having received 70-80 r at weekly intervals. The average number of treatments was 5. The average total dosage for 159 patients prior to 1943 was 252 r. Relief of the disease generally occurred, while evidence of cataract formation was demonstrated. The conclusions are that: the roentgenologist can aid the ophthalmologist in the treatment of inflammatory diseases of the eye; roentgen rays used carefully will not produce any damage to the eye and will relieve intense pain and the inflammation of a corneal ulcer in the majority of the patients; and, the treatment of blepharitis is not aided by roentgen therapy.

577 Roentgentherapy in cancer of the hypopharynx. Francois Baclesse. J. Am. Med. Assoc. 140, 525-30(1949) June 11.

A description is presented of the classification, technique of treatment and the survival rates of cases of cancer of the hypopharynx. The hypopharynx is divided into two sections for the purpose of classification, the upper and lower sections, and cancers of the two areas may be described as: (1) cancers of the upper part, including the epitheliomas of the ary-epiglottic fold and the antero-superior part of the pharyngo-laryngeal fold, which can be cured when they are proliferative, and (2) cancers of the lower part, including those deep in the pyriform sinus, lesions involving the postero-pharyngeal area of the arytenoid and the cricoid, and the mouth of the esophagus, or the posterior wall of the hypopharynx. Tumor doses are given, and extend up to the limit of tolerance of the tissues, 7,000-8,000 r, at the end of a 12-week period. Four tables are included which list the roentgen therapy and the course of patients apparently cured of carcinoma of the hypopharynx, and the 5-year results with oropharynx and

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nasopharynx epitheliomas. The technique stressed is large radiation doses in small fields, over a long period of time, with minimal involvement of surrounding areas. In conclusion, it is stated that ulcerating tumors will continue to remain a difficult problem, and that radiologists, collaborating with biologists, should search for methods of increasing the sensitivity of these tumors.

578 Roentgen therapy for carcinoma of the larynx. Fifteen years experience. William Harris, Rudolph Kramer, and Sidney M. Silverstone. Radiology 51, 708-15(1948) Nov.

A discussion of the results of the x-ray treatment of 67 cases of carcinoma of the larynx is presented in which the 5-year survival-rate for the intrinsic cases (involving the ventricles, the true cord, the anterior commissure, the posterior commissure, or the subglottic region) was 73%. The 5-year cure rate for the extrinsic cases (involving the epiglottis, the aryepiglottic folds, the ventricular bands, the arytenoids, the piriform sinuses, or the post-cricoid region) was 40%. The irradiation technique usually consisted of 75-100 r to an anterior field for the first five days, and then treatments to the right and left lateral fields, with a daily dose of 250-300 r measured in air—125-150 r to each lateral field. Radio-epithelitis and radio-epidermitis usually occurred and cleared up after the radiation course ended. The 5-year survival rate for all the cases was 55%. Small early lesions had the best prognosis, while involvment of the piriform sinus, arytenoid, or post-cricoid region indicated an unfavorable outcome.

579 Roentgen therapy of carcinoma of the lower lip. J. A. Del Regato. Radiology 51, 499-508 (1948). Oct.

The technique and results in the treatment of carcinoma of the lower lip with roentgen ray therapy are presented. A single application of unfiltered radiations is incapable of controlling the carcinoma, and often results in marked atrophy, visible defects, and late superficial necrosis which increase with the size of the field. Filters of 0.25 mm and 0.5 mm Cu are used with daily doses of 100-300 r over a period of 1-6 weeks. In long treatments, the daily dose is increased several times and the total dosage delivered is 3,000-7,000 r. Atrophy, fibrosis, telangiectasis, and achromia may result from improperly treated radio-epithelitis and radio-epidermititis. A total of 195 patients received no treatment, surgical treatment, curie therapy, or roentgen therapy. Ten per cent eventually died from cancer. The conclusions are: roentgen therapy is the treatment of choice; adequate irradiation requires a balance of factors; a prophylactic neck dissection is not justified as routing procedure; and, metastatic adenopathies from carcinoma of the lip are best treated by a supra-omohyoid neck dissection.

580 Roentgen therapy for hyperhidrosis. J. Borak, J. J. Eller, and W. D. Eller. Arch. Dermatol. and Syphilol. 59, 644-52(1949) June.

The results of successful treatment by roentgen therapy of 122 patients with hyperhidrosis, or excessive perspiring, are given. The palms, axillas, and soles of the feet are the most common sites for hyperhidrosis. A discussion of the signs and symptoms of the malady, the anatomy and sensitivity of the sweat glands, and the technique of irradiation is presented. The lethal single-exposure dose for the sweat glands is 2,400 r, and for the sebaceous glands is 1,200 r (tissue roentgens). It is thought that the total dose required to produce atrophy of the sweat glands is 40%, that necessary to destroy a small basal cell cancer. When filtered rays are used no skin reaction occurs. The usual treatment is a dose of 300 r in air delivered at a focal distance of 35-45 cm through a 2-4 mm Al filter with a 140 kv machine; this is followed by half-doses administered twice at 10 day intervals. This series is repeated, if necessary, in the same manner after a period of 4 weeks. Thus, a total dose of 1,200 r in air (about 1,600 r on the skin) is administered in 6 treatments within 8 weeks. No radiation injury occurred in any of the patients treated. For a large number of patients the results were very satisfactory. It is concluded that properly applied roentgen therapy is the best method of treating hyperhidrosis, and that the use of unfiltered rays is the most important reason for the failure of this therapy.

BIOLOGY AND MEDICINE (continued)

581 The study of connective-tissue reaction to radiation. The sieve or chess method. B. Jolles. Brit. J. Cancer 3, 27-31(1949) Mar.

A new method and an apparatus designed to facilitate study of the effects of radiations on human connective tissue are described, together with some preliminary results of the investigations. Accessible tumors (breast and skin) were irradiated through a Pb sieve with circular or square apertures of diameters varying from 1.0 cm to 2.0 cm. Very advanced, inoperable tumors were used in this investigation. The Pb sieve was applied tightly over the part to be irradiated by means of a special individual mold applicator. The thickness of the lead permitted 3% of the radiations to pass through on to the protected surface. Histological sections were taken at different times before, during, and after the radiations, and comparable areas of the exposed and protected tumor were critically examined. The results show that the connective-tissue reaction takes place not only in the irradiated areas, but also in the neighborhood protected from the direct irradiation. This reaction consists of a deposition of an excessive amount of collagenous fibrils, which are organized into solid, coarse bundles in the exposed parts where the fine connective-tissue network is grossly altered. Lymphatic channels and blood capilaries are greatly affected, compressed, and blocked. It is concluded that the sieve-method is a workable technique for the study of direct and indirect effects of irradiation.

582 Techniques for application of the betatron to medical therapy. H. Quastler, G. D. Adams, G. M. Almy, S. M. Dancoff, A. O. Hanson, D. W. Kerst, H. W. Koch, L. H. Lanzl, J. S. Laughlin, D. E. Riesen, C. S. Robinson, Jr., V. T. Austin, T. G. Kerley, E. F. Lanzl, G. Y. McClure, E. A. Thompson, and L. S. Skaggs. Am. J. Roentgenol. Radium Therapy 61, 591-625(1949) May.

A report of the treatment of a case of glioblastoma with 20 million volt roentgen rays and with the betatron is given in detail. A discussion is presented on the appraisal of risks of high energy roentgen rays and their dosimetry, and a practical unit for clinical use is defined. Several three-dimensional depth dose distributions are given, and a collimator to produce a beam of a cross section is described, as well as a compensating filter to equalize the intensity distribution across the beam. Problems of shielding and protection are discussed, and a plan for cross-firing a tumor in the temporal lobe, techniques for testing the plan and the treatment developed by the plan are given. Following a brain operation for the glioblastoma, post-operative radiation therapy was given to the patient and consisted of 250 r per day, alternating right and left sides, for a total of 10 days. The resulting tissue dose was about 1700 r through the tumor area. After a short period of time, radiation therapy with the betatron was initiated, and a total of 4,669 r.e.b.a. (rontgen equivalents by bio-assay, a term defined in this article) was delivered over a 17-day period. Terminally, the patient died from a pulmonary congestion. A tentative evaluation of the possibilities of high energy therapy in cancer cases is given. 12 references, 24 figures, 1 table.

583 The therapeutic use of radioactive elements in malignancy. P. F. Hahn and C. W. Sheppard. Ann. Internal Med. 28, No 3, 598-606(1948).

A review of the therapeutic use and the possibilities for some of the radioisotopes is presented, in which is included a table listing the principle characteristics of 18 isotopes. The physical, biological, chemical, and economical requirements necessary for the application of these isotopes to clinical investigation and therapy are discussed. P^{32}, Mn^{52}, Cu^{64}, As^{74}, Y^{90}, Ag^{111}, I^{130}, I^{131}, and Au^{198} are discussed in some detail.

584 Treatment of giant-cell tumours of bone....with a review of twenty-five cases. T. M. Prossor. J. Bone and Joint Surg. 31, 241-51(1949) May.

Twenty-five cases of benign giant-cell tumors of the bone, treated at the Westminster Hospital, London, are reported in which the therapy was treatment by x-radiations or by teleradium. The x-radiations were given in one, two, or three courses and were high voltage radiations at 620-3,080 r for the first course, 876-3,240 r for the second course, and 1,000-2,160 r for the third course. Teleradium treatments were also given in three courses, and in combination with the x-radiations. The teleradium treatments varied from 2,400 r to 3,255 r for the first course, 2,400-4,429 r for the second

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course, and 2,100-2,300 r for the third course. The responses to both the x-radiations and the teleradium treatments were very satisfactory. In the first x-ray course a daily skin dose of 200 r and a tumor dose of 90 r were given at the rate of 34 r per minute. The average duration of treatment was four weeks, and the total average dose was 2,000 r. A second similar treatment was given six months later, and when necessary, a third course. In cases of teleradium therapy, one daily treatment of 50 minutes was given for 20 days, so that 245 r were delivered to the tumor in 48 hours. It is concluded that some cases of giant-cell tumors of the bone must be treated by excision, but in general, irradiation is the treatment of choice. 48 references.

585 Treatment of osteoclastoma by radiation. Frank Ellis. J. Bone and Joint Surg. 31-B, 268-80(1949) May.

The problems of diagnosis and treatment of osteoclastoma are discussed. The method of treatment for the cases reported is x-radiation, and consists of a total of 3,000 r administered on alternate days over a period of three weeks. Occasionally a second radiation course is given. The rays are directed only to the lesion itself and not to the surrounding area. The results of the treatment in this series of 26 cases are good. Brief summaries of the individual cases, including the therapy and the results are given. In these cases the x-radiations were 500-7,000 r for osteoclastoma at a variety of sites. The problems of apparent extension of the lesion after irradiation and the transformation of the lesion to a malignant form are discussed. In view of the possible arrest or delay of epiphysial growth due to the radiations, the author concludes that radiations should not be given to children less than 10 years old for simple bone cysts, but that radiations are advisable in cases of true osteoclastoma. It is also concluded that curretage, excision, and amputation for benign osteoclastoma are unnecessary.

586 The treatment of retinal glioma. E. M. Japha. Brit. J. Cancer 3, 16-26(1949) Mar.

A review of the literature on the treatment of gloima retinae is presented, and 19 cases seen at the Middlesex Hospital between 1929 and 1946 are described as regards age and sex incidence, length of history, side affected, family history, pathology, and treatment. The methods of treatment are surgery, surgery and radiotherapy, or radiotherapy alone. Fifteen cases of primary and post-operative irradiation by radium or x-rays are summarized. Doses of 1,400-3,800 r were delivered by externally applied radium molds, and both cases treated more than five years ago are in good health. X-rays were used as the primary radiation in 3 cases more than five years ago, two of which are alive and well. The daily dose was 100-300 r to one or two fields, and the course usually lasted 3-6 weeks. The highest dose applied was 4,750 r in 57 days. All other applied skin doses were below 2,700 r, and in many cases a moist desquamatous skin reaction was produced, which healed within a month, leaving no late sequelae. Post-operative irradiation consisted of doses of 660-3,570 r for three cases, in one of which there was a recurrence. The complications developing as a result of radiotherapy were cataract formations, recurrences of the gliomas, and radiation skin burns. 14 references, 7 tables.

587 Tretament of secondary amenorrhoea with low dosage irradiation of ovaries and pituitary gland. P. Lyon Playfair and Alan Booth. J. Obstet. Gynaecol. Brit. Empire 56, 260-8 (1949) Apr.

Twenty-one cases of secondary amenorrhoea treated by small dosage irradiations of the pituitary gland and the ovaries are described. High voltage therapy was used, consisting of 200 kv at 15 ma with a filtration of 1.5 mm of Cu and 1 mm of Al at a focal distance of 50 cm. The ovaries were treated through the right and left posterior fields, and the pituitary was given two doses of 75 r, 13 days apart. The ovaries were given three doses of 75 r in 13 days, concurrent with the pituitary irradiation. Sexual alterations, age selection of cases, hypoplasia, peritoneoscopy, and oestrogens are discussed briefly. In 66.6% of the cases a normal periodicity was introduced, in 9.5%, the periodicity was improved, and in 23.9% of the cases, the treatment failed. It appears that the cases in which the period of amenorrhoea existed not more than 30 months before irradiation improved the most under the therapy. 14 references.

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588 Treatment of thyroiditis. George Crile. Arch. Surg. 57, 443-9(1948) Oct.

Six cases of subacute thyroiditis, struma lymphomatosa, and Riedel's struma are presented in which the roentgen therapy of these 3 types of thyroiditis are described. The treatment of the subacute thyroiditis cases usually consists of 600-800 r delivered in a short period of time. This disease responds quickly to the treatments and does not require thyroidectomy. About 1,500 r is the usual total dose given in cases of struma lymphostomata, but the radiation therapy and thyroidectomy are only symptomatic treatments; no permanent effects can be obtained. Reidel's struma is unaffected by roentgen therapy, even at the 2,500 r level.

589 The use of radioarsenic (As^{76}) in the treatment of leucemia and allied disorders of the hematopoietic tissues. Matthew H. Block, Leon O. Jacobson, William B. Neal, Jr., and Taylor R. Smith. J. Lab. and Clin. Med. 33, 1649-50(1948) Dec.

Nineteen patients with tumors of the hematopoietic system have been given As^{76} in doses of 1-80 mc with 3-10 mg of stable arsenic administered intravenously. Preliminary studies indicated that each mc was equivalent to one r of whole body radiation. The results were variable with cases of myelocytic leucemia, depending on the degree of severity of the cases and the presence or absence of prior therapeutic treatments. Three patients with chronic lymphocytic leucemia were not benefited, while one patient with polycythemia vera benefited temporarily from the therapy. Patients with Hodgkin's disease and multiple myeloma did not respond to the low dosage treatments.

590 X-ray therapy of inflammatory lesions of the eyelids. Edward C. Albers and H. M. Buley. Illinois Med. J. 95, 355-9(1949) June.

A discussion of the history and techniques of x-ray therapy for cases of inflammatory lesions of the eyelids is presented. Two types of lesion cases are mentioned, the chronic and the acute. Acute lesions should be treated as early as possible with small doses within the range of 10-20% of an erythema dose; this technique gives optimal results. The field of irradiation should include the entire lesion plus an area of apparently normal surrounding tissue, and with more virulent reactions, extensive edemas, and large fields, a dose of x-rays should be used. A relatively soft type of irradiation is used so that often only an exacerbation of short duration occurs after the treatment. In subacute and chronic infections, the choice of the field and the quality of the rays is the same, but the individual dose is 25-35% of an erythema dose. This amount is repeated at intervals of 5 to 10 days until the erythema dose (about 400 r) has been delivered. The roentgen therapy is considered a supportive treatment measure in these cases. The acute inflammations receive 40-80 r as a dose, the chronic cases 100-130 r, and the subacute cases 70-100 r. The reactions of the palpabral infections and chronic meibomianitis cases to the ray therapy are described. In general, the results are good. It is concluded that roentgen therapy is a valuable aid in the treatment of infectious inflammatory conditions of the eyelids, and when used properly does not endanger the eye globe. The ray therapy is preferable to penicillin therapy in these cases. 10 references.

591 X-rays and radium in the treatment of diseases of the skin. George M. MacKee. Lea and Febiger, Publishers, Minneapolis, 1946. 668p.

Approximately the first half of this book is concerned with the essentials of physics and biology. The various forms of radiation, methods of measurement, dosages, control techniques, and the biological effects of the radiations on the organs and tissues of the body are fully discussed. The last part of the book discusses clinical uses and problems for the application of radiation therapy. Several chapters cover the methods of treating diseases caused by fungi or due to pyogenic organisms, eczema, psoriasis, lichen planus, pruritis, hypertrichosis, diseases of the hematopoietic system, diseases due to the tubercle bacillus, verrucous lesions, nevi, and benign and malignant new growths. The medico-legal aspects of x-ray and radium therapy are also discussed.

BIOLOGY AND MEDICINE (continued)

592 Barium metabolism in hornets studied by means of radio-isotopes. V. T. Bowen. AECU-260, nd. 7p.

Since histochemical and microchemical methods for barium are far from satisfactory, this study has been carried on using the radioisotope, barium^{140}, obtained from Oak Ridge, as indicator of the normal pathways of barium through the body. The distribution of ingested barium^{140} within the organisms was studied both by conventional Geiger-counter examination of dissected organs and by radioautography. The barium distribution in the organs of the abdomen of male hornets is tabulated. The cycles of barium distribution are discussed.

593 The significance of phosphorus in the metabolism of E. coli in studies with P^{32}. Benjamin A Rubin and Paul Steinglass. AECU-268, nd. 1p.

This document is in abstract form; it is reproduced below in its entirety.

In studying the effects of internal radioactive phosphorus (P^{32}) on E. coli it became necessary to investigate the question of how one might cause the incorporation of different concentrations of P^{32} while maintaining comparable growth characteristics. Absorbed P^{32} was varied by changing the ratio of carrier to active phosphorus. As levels of total phosphorus in the medium were increased, the absolute amount retained by the cell increased but the proportion of the total retained varied inversely with concentration in the medium. Fractionation experiments with P^{32} after ultrasonic disruption of the cells, indicated that phosphorus was largely inorganic. The ease with which inorganic phosphorus was eluted may be indicative of its superficial location. The relationship between total phosphorus concentration and total growth was determined. By substituting another buffering system (borate) it was shown that, within limits, total growth was dependent upon buffering capacity. By using the borate buffer mixture, it was possible to obtain comparable growth over a wide range of phosphorus levels.

594 Incorporation of radioiron into cytochrome C. L. M. Sharpe and J. Raymond Klein. AECU-273, nd. 1p.

This document is in abstract form; it is reproduced below in its entirety.

Adult male Peking ducks were injected intraperitoneally with about 0.6 mg iron per kg body weight, the iron being in the form of ferric ammonium citrate and containing approximately 0.8 and 5 μc of radioactive Fe^{59} and Fe^{55}, respectively, per 0.6 mg. At intervals following injection of the iron its concentration in the iron of erthrocytes, plasma, muscle, and the cytochrome C of muscle was determined by means of assay for Fe^{59}. The rate of increase in concentration for muscle was greater than for erthrocytes or cytochrome during the first few days after administration of the iron. The concentrations for muscle and erthrocytes approached the same level at about the sixth day, that for cytochrome being somewhat lower. The rates at this time all became and continued approximately the same for an additional five weeks. The appearance of administered iron in avian erythrocytes in vivo may be a function of transfer of iron from plasma to erthrocytes as well as cell formation since in vitro iron diffuses from plasma to cells.

595 Distribution in the duck of intraperitoneally administered radioiron in erythrocytes, muscle, cytochrome C of muscle, and plasma. J. Raymond Klein and L. M. Sharpe. AECU-336, nd. 15p.

The rate of appearance of intraperitoneally administered radioiron in the iron of erythrocytes, muscle, the cytochrome C of muscle, and plasma was measured. The concentration of injected iron in that of plasma, initially comparatively high, decreased with time while the concentrations for the other substances increased. The rate of increase was highest for muscle and lowest for cytochrome. About one month after the administration, the concentrations of injected iron in that of all parts of the animal were about the same. When the concentration of administered iron in that of all substances is the same it appears possible to estimate the concentration of total body iron in the intact animal.

BIOLOGY AND MEDICINE (continued)

596 The use of radioiodine and paper chromatography technique in the study of thyroid metabolism. Garson H. Tishkoff, Robert Bennett, Vera Bennett, and Leon L. Miller. AECU-344, May 10, 1949. 10p.

It has been suggested that several of the radioactive products of unknown nature previously reported in thyroid hydrolysates may have arisen from the interaction of the radioiodide and the phenol solvent which was employed. This paper reports the results of a series of experiments aimed at characterizing the iodinated products of alkaline thyroid hydrolysates using a two-dimensional paper partition procedure modified to avoid the interaction of the radioiodide with the solvents employed. The presence in the thyroid of thyroxin, mono- and diiodotyrosine, and possibly diiodothyronin, as well as several iodine containing substances of unknown nature, was established.

597 Absorption of radioactive phosphorus by mycorrhizal roots of pine. Paul J. Kramer and Karl M. Wilbur. Science 110, 8-9(1949) July 1.

A method is described for determining the amounts of phosphorus accumulated in mycorrhizal and non-mycorrhizal roots of pine seedlings through root immersion in radioactive phosphorus and the subsequent preparation of radioautographs. The species used were the loblolly pine (Pinus taeda L.) and the red pine (Pinus resinosa Ait.). Pieces of the tree roots were immersed in P^{32} solutions of concentrations of 100-500 μc, according to the different experiments. The roots were exposed for 3-4 hr to the solutions, rinsed, and then placed beneath film slides from a few hours to a few days. The results show that there is less phosphorus accumulated in the completely suberized portions of the main roots than in the unsuberized regions near the root tips. It seems possible that mycorrhizal roots have not only a greater surface, but also a greater capacity to accumulate phosphorus per unit of surface than non-mycorrhizal roots. Apparently in pine roots the region of maximum intake of minerals is where mycorrhizal or pseudo-mycorrhizal roots have developed.

598 Action of 2-(p-aminophenyl)-thiazol containing radioactive S^{35} upon the tuberculosis bacillus. II. H. Erlenmeyer, H. Meyer, H. Noll, and E. Sorkin. Helv. Chim. Acta 32, 1209-13(1949) (in German).

Para-aminophenyl thiazol labelled by S^{35} was added, in various concentrations, to the synthetic nutritive solutions containing tuberculosis bacilli, and the activities were measured that correspond to the quantities of p-aminophenyl, absorbed by isolated bacteria, which determine a growth-inhibiting action upon the culture.

599 Deuterium oxide and thiocyanate spaces in protein depletion. V. Hollander, P. Chang, and Co Tui. J. Lab. Clin. Med. 34, 680-6(1949) May.

Experiments involving the use of deuterium oxide and thiocyanate to determine the total body water and extracellular fluid in cases of protein depletion are described. The calculation of intracellular fluid is obtained by the simultaneous determination of the total body fluid and the extracellular fluid. The various disadvantages of using thiocyanate are pointed out. The study on humans was divided into three classes: (1) a study of two normal subjects, (2) three cases of protein depletion, and (3) a detailed study of the rehabilitation of two cases of protein depletion by the use of very high protein intakes. The preliminary work described is the first study of the body compartments and constituents in protein depletion. Results show that there is a profound disturbance in both the body constituents and compartments in protein depletion. The disturbance in water metabolism seems to be in the thiocyanate spaces and in the intracellular compartment. 38 references.

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600 Distribution of ribonucleic acid in the cytoplasm of growing cells studied with P^{32}. R. Jeener. Nature 163, 837(1949) May 28 (Letter to the editor).

Labelled phosphorus, P^{32}, was injected into gravid mice, hen's eggs, and into pigeons (which had been fed a crop-enlarging diet of prolactin) in order to determine the distribution of ribonucleic acid within the cytoplasm of cells obtained from various organs by extraction. The technique and method involved are described. On the bases of the variations in radioactivity between extracts which were centrifuged for different periods of time, it is concluded that nucleic acid is at least partly associated with sub-microscopic particles (granules, microsomes, lipo-nucleoproteins, etc.) obtained by centrifugation, and that these particles really exist in the cytoplasm of living cells. It is concluded that the observed differences in radioactivity between the three extracts must also be present in vivo.

601 The effects of choline and methionine on phospholipide formation in patients with liver disease as measured by radioactive phosphorus. David Cayer and W. E. Cornatzer. Science 109, 613-5(1949) June 17.

Some results obtained from two cirrhotic patients through the study of their responses to large doses of methionine and choline are presented here, as part of a current systematic study of the turnover of phospholipides in normal humans and in patients with a variety of diseases. One 31-year-old white male and one 36-year-old white female having clinical evidence of advanced portal cirrhosis were studied. At the time of admission, both were jaundiced and had demonstrable ascites, edema, and hepatic enlargement. Both gave a history of marked alcoholism. Impairment of the liver function in both cases was found. The patients were given an intramuscular injection of radiophosphorus in the form of Na_2HPO_4 (0.5 mc). Blood samples were taken routinely at 0, 24, 48, and 72 hr. The plasma was separated and the lipids extracted and tested for radioactivity. At the time of the phosphorus injection the patients were given large doses of methionine and choline chloride, and several months treatment with methionine followed. Determinations of the plasma lipids were again made, and for a third time following a large injection of the combined substances (methionine and choline). The results show that an initial dose of the lipotropic substances produced an initial drop in the rate of phospholipide turnover, and that such an increase was no longer obtainable after prolonged methionine therapy. In certain instances of chronic hepatitis, the use of lipotropic substances is thought to be of therapeutic value. It is suggested that the stimulatory effect of a large single dose of methionine on the rate of turnover of the phospholipides may indicate a deficiency of lipotropic material, and thus provide an estimate of the anticipated response to the treatment of cirrhosis with lipotropic substances.

602 The effect of temperature on potassium equilibria in chick embryo muscle. Laurence G. Wesson, Jr., Waldo E. Cohn, and Austin M. Brues. J. Gen. Physiol. 32, 511-23(1949) Mar. 20.

The effect of temperature upon the exchange rates between intra- and extra- cellular potassium in the chick embryo muscle was determined through the use of radioactive potassium (K^{42}). The methods and calculations are included; the K^{42} was measured at intervals of 15-60 minutes by means of a Lauritsen electroscope or a Geiger-Müller counter. The results show that the temperature coefficient of at least four-fifths of the cell potassium is large and that at temperatures below 15°C, potassium is lost from the cell, but is regained on warming. These results indicate the possibility that 20% or less of the cell potassium may differ from the rest by being more rapidly exchangeable with the medium. 25 references.

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603 The effect of thyroid activity on certain anabolic processes studied with the aid of deuterium. Adele Karp and DeWitt Stetten, Jr. J. Biol. Chem. 179, 819-30(1949) June.

The rates of incorporation of deuterium from the body water into the glycogen, fatty acids, and sterols of liver and carcass, as well as into the protein of liver, have been studied in immature rats. Normal rats, rats fed thiouracil, and rats fed thyroid gland have been compared. The rate of rise in deuterium concentration of each constituent was greater than normal when thyroid substance was fed. A possible interpretation of these findings is given. In contrast to other situations in which diminution in the quantity of body fat has been studied, the cachexia of hyperthyroidism has been found not to be accompanied by an interference with fatty acid synthesis.

604 Exchange of materials in a lake as studied by radioactive phosphorus. C. C. Goffin, F. R. Hayes, L. H. Jodrey, and S. G. Whiteway. Nature 163, 963-4(1949).

The rate and the amount of uptake of radioactive phosphorus in a lake by the organisms present are described. An experiment was performed in which 100 mc of P^{32} were mixed into a small acid bog lake, and samples of the plankton, fish, algae, sphagnum, and other organisms were taken at intervals up to eight weeks later. Maximal values were observed for the uptake of radioactive phosphorus in algae and sponges in relation to the normal total phosphorus. They were the simplest forms of active organisms present. Sphagnum values were much lower, and values for fish and higher plant forms were still lower. Reasons for these values are discussed in an effort to ascertain the mechanism of incorporation of the phosphorus.

605 Extracellular water content of the heart in dogs subjected to hemorrhagic shock measured with the radioactive isotope of sodium. Ned D. Rodes, Janet M. Lemley, Alice B. Dale, Sam E. Stephenson, Jr., and George R. Meneely. Am. J. Physiol. 157, 254-8(1949) May 1.

Experiments measuring the extracellular water content of the myocardium, when the subjects are in a state of shock, through the use of Na^{24} are described. Three groups of dogs were used and were treated separately in three experiments. The first group was subjected to severe hemorrhagic hypotension to produce irreversible shock by the technique of Wiggers (Proc. Soc. Exptl. Biol. Med. 49, 604(1942)). The second group represented positive controls and the dogs were treated in the same manner as the shock dogs, but were not bled. The third group, which served as negative controls, was given large and rapidly administered intravenous infusions of saline. Details of the experiments are given; they include a dry ash method of assay of the heart tissue after the injection of radioactive sodium chloride. This injection took place during the course of the experiment. The positive control dogs showed a water content in the myocardium of 23.5% of the wet weight of the tissue; the dogs under hemorrhagic shock showed a water content of 24.7% of the tissue weight. Therefore, there is no significant difference in the water content of the myocardium under normal and hemorrhagic shock conditions in dogs.

606 The incorporation of labeled lysine into the proteins of guinea pig liver homogenate. Henry Borsook, Clara L. Deasy, A. J. Haagen-Smit, Geoffrey Keighley, and Peter H. Lowy. J. Biol. Chem. 179, 689-704(1949) June.

Two sets of conditions were found in guinea pig liver homogenate in which L-lysine (labeled with C^{14} in the ϵ position) is incorporated into the proteins in relatively large amounts. In one case the enzyme system was the whole homogenate, in the other the precipitate obtained by centrifuging the 15-fold diluted homogenate at 2500 g. Characteristics of the reactions with the whole homogenate and with the sedimented fractions are described. The rate of incorporation of labeled lysine into the proteins of the whole homogenate is approximately the same as that in vivo; after 1 hr incubation at 38° about 0.15% of the lysine in the proteins is labeled. This rate is 60 times faster than any hitherto reported in whole homogenates for other amino acids. The rate of incorporation of labeled lysine into the proteins of the sedimented fraction, under the most favorable conditions for the latter, is several times that in the whole homogenate under its most favorable conditions. All the radioactivity found in the proteins of the whole homogenate was accounted for as labeled lysine.

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607 An isotopic study of porphyrin and hemoglobin metabolism in a case of porphyria. Moisés Grinstein, Robert A. Aldrich, Violet Hawkinson, and Cecil James Watson. J. Biol. Chem. 179, 983-4(1949) June (Letter to the editor).

A case of "light-sensitive" (congenital) porphyria is presented in which the hemoglobin and porphyrin metabolism was studied through the use of glycine containing N^{15}. The patient, a girl of 4 years, was given 15 g of labeled glycine over a 3-day period. The results of serial determinations of the N^{15} content in the hemoglobin protoporphyrin, coproporphyrin I and uroporphyrin I in the urine, and the stercobilin in the feces are given in a table. The conclusions are that the increased concentration of N^{15} in the hemoglobin protoporphyrin may be due to the marked increase in erythropoiesis exhibited in the patient. The N^{15} concentration increase for the other factors may indicate their derivation from a common pyrrole precursor.

608 Metabolic functions of biotin 1. The role of biotin in bicarbonate utilization by lactobacillus arabinosus studied with C^{14}. Henry A. Lardy, Richard L. Potter, and R. H. Burris. J. Biol. Chem. 179, 721-31(1949) June.

To obtain further information on the function of biotin, studies were made of the uptake of C^{14}-labeled bicarbonate by normal and biotin-deficient cells of L. arabinosus. The methods, materials, and results are described. When grown in the presence of 2 mμg of biotin per ml, cells of L. arabinosus fixed C^{14} from the bicarbonate of the medium into cellular aspartic acid. The bacillus cells were almost completely unable to fix CO_2 when they were grown in media containing only 0.05 mμg of biotin per ml. Biotin analogues having antimetabolite properties inhibited the fixation of CO_2 when added simultaneously with biotin cells. They had little influence on the CO_2-fixing capactiy of cells grown in the presence of biotin. 20 references.

609 The metabolism of C^{14}-labeled glucose by the rat diaphragm in vitro. Claude A. Villee and A. Baird Hastings. J. Biol. Chem. 179, 673-87(1949) June.

The glucose disappearance, glycogen synthesis, and metabolism of glucose to carbon dioxide by the isolated rat diaphragm have been measured in muscle from normal, diabetic, adrenalectomized, hypophysectomized, adrenalectomized-hypophysectomized, and diabetic-adrenalectomized rats through the use of C^{14}-labeled glucose. In all types of animals, the addition of insulin increased the amount of glucose disappearing from the medium and the amount of glycogen synthesized. Insulin increased the amount of glucose carbon appearing in carbon dioxide in all but the diabetic diaphragm, in which the increase was not significant. When no insulin was added to the medium, the glucose utilization and glucose metabolized to carbon dioxide were lower than normal in muscle from diabetic rats and greater than normal in muscle from adrenalectomized, hypophysectomized, and adrenalectomized-hypophysectomized rats. Glycogen synthesis when no insulin was added was lower than normal in muscle from diabetic and adrenalectomized rats and greater then normal in muscle from hypophysectomized, diabetic-adrenalectomized, and hypophysectomized-adrenalectomized rats. 16 references.

610 Methods for the determination of the distribution of radioactive phosphorus among the phosphorus-containing constituents of tissues. J. A. McCarter and Ethel L. Steljes. Can. J. Research 26, 333-46(1948) Dec.

The phosphorus-containing constituents of various tissues of the rat were separated into five fractions. These were: inorganic and organic phosphorus soluble in aqueous 10% trichloroacetic acid; phosphorus soluble in 3 : 1 alcohol-ether; phosphorus derived from ribonucleic acid; and phosphorus derived from thymonucleic acid. In order to test the methods, inorganic phosphate, disodium phenyl phosphate, and purified ribonucleic and thymonucleic acids were added to a homogenate of rat liver in 10% trichloroacetic acid. It was possible by separation and analysis of the fractions to obtain a quantitative recovery of the added phosphorus in the appropriate fractions. Data are given showing the radioactive and nonradioactive phosphorus contents of the various fractions of liver, spleen, and other glands 24 hr after the intraperitoneal injection of a solution of radioactive inorganic phosphate. When

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the fractionation was performed at room temperature it was found that all of the fractions except the organic acid-soluble phosphorus fraction contained negligible amounts of the added radioactive phosphorus. The amount of radioactive phosphorus taken up by this fraction could be reduced to a negligible quantity by working quickly and with cold solutions. 12 references.

611 On the nitrogen turnover in purines from polynucleotides determined with glycine N^{15}. Peter Reichard. J. Biol. Chem. 179, 773-81(1949) June.

The investigation described was carried out in order to determine if guanine could be synthesized by way of adenine. Included is a method for obtaining the corresponding hydroxypurines from small amounts (2 to 8 mg) of adenine and guanine. Intestine and regenerating liver cytoplasm from a previous experiment (A. Bergstrand, et. al., Cold Spring Harbor Symposia on Quantitative Biology 13, (1948)) in which N^{15}-glycine had been injected into rats has been worked up for aminopurines of PNA and DNA (ribonucleic acid and desoxyribonucleic acid). These were degraded to the corresponding hydroxypurines. Evidence has been obtained that the main part of guanine in PNA from regenerating liver cytoplasm and from DNA in the intestine is not synthesized via adenine. In the case of PNA from the intestine, this possibility could not be excluded. 12 references.

612 Preparation of a radioactive iodotetrazolium salt and its distribution in mice. Arnold M. Seligman, Ralph Gofstein, and Alexander M. Rutenburg. Cancer Research 9, 366-9(1949) June.

The synthesis of 0.01 millimoles of 2, 5-diphenyl-3 p-radioiodophenyl tetrazolium chloride from radioactive iodine, I^{131}, is described. Following an intravenous injection of the iodotetrazolium salt in both normal and tumor-bearing mice, the radioactivity disappeared rapidly from the circulating blood. In 30 minutes the level of radioactivity was 3-4% that at injection time, and after 8 hr it was 0.5%. The highest concentration of radioactivity was found in the kidney, liver, and lung, after an injection of 0.1 mg while the lungs showed the greatest concentration after an injection of 0.2 mg. All other tissues were less radioactive; sarcoma 37 was less radioactive than most of the tissues, but lost its radioactivity at the same rate. There was no appreciable difference in the levels of radioactivity in the tissues of normal and tumor-bearing mice. 22 references.

613 Proceedings of the Physiological Society of Philadelphia for the session of March 15, 1949. Am. J. Med. Sci. 217, 708-11(1949) June.

Among the papers presented at the session of the Physiological Society of Philadelphia on March 15, 1949, was the following: Isotopic Studies of the Biosynthesis of Nucleic Acid Components. Part I. Purines and Pyrimidines. Milton R. Heinrich, D. Wright Wilson, and Samuel Gurin.

614 Radioactive isotopes in the study of peripheral vascular disease. I. Derivation of a circulatory index. Morris T. Friedell, Fenton Schaffner, William J. Pickett, and Irvin F. Hummon, Jr. Arch. Internal Med. 83, 608-19(1949) June.

Methods of determining the peripheral blood supply, with a consideration of the use of radioactive tracers in this problem, are discussed. The present study is on 100 patients from the wards of the Cook County Hospital. These patients were each given an intravenous injection of 200 mc of P^{32}, and the deposition curves of the radioisotope were plotted. A straight line slope was obtained im most cases, its reciprocal being considered the index of circulation. These indexes fell into a pattern, and the patients with arteriosclerosis or those over 50 years old could be easily grouped since the diffusion of P^{32} into the tissues was faster for these patients. Capillary dilatation is thought to be the chief cause of this phenomenon.

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615 Radioactive isotopes in the study of peripheral vascular disease. II. Method of evaluation of various forms of treatment. Fenton Schaffner, Morris T. Friedell, William J. Pickett, and Irvin F. Hummon, Jr. Arch. Internal Med. 83, 620-31(1949) June.

The derivation of an index of circulation, calculated from the rate of diffusion of intravenously injected radioactive phosphorus into the tissues of the lower extremity, is reviewed and the effect of treatment on this index of circulation was determined. Four forms of treatment were used: (1) administration of histidine monohydrochloride and ascorbic acid, (2) lumbar sympathetic block with procaine hydrochloride, (3) administration of test doses of 500 mg of tetraethylammonium chloride, and (4) lumbar sympathectomy. Thirty-four series of these determinations were made on 26 patients who were classified into four groups according to their circulatory index, and injections of 200 mc of P^{32} were made. The variations in the circulatory indexes were interpreted as signifying the response of the capillary bed to peripheral vasodilators. The capillaries are considered to have an independent circulation, based largely on the demand for and deficit of oxygen. Radioactive phosphorus is considered useful as a diagnostic and prognostic tool in the evaluation of peripheral vascular states, such as arteriosclerosis obliterans.

616 Radioactive phosphorus in biochemical research. W. D. E. Thomas and D. J. D. Nicholas. Nature 163, 719(1949) May 7 (Letter to the editor).

The general requirement of using stable and radioactive isotopes of the same chemical configurations when applying radioactive tracers to biochemical problems was not conformed to in the experiments described. A sample of radioactive disodium hydrogen phosphate, prepared by slow neutron bombardment, was used. The irradiated salt was applied in aqueous solution to the roots of growing plants. At the end of the experiment, it was determined that less than 1/2 of the original radioactive salt was present as orthophosphate. The remainder had been converted to some other compound. It is concluded that in view of the increasing interest in the application of radioactive tracers to biochemical investigations, it is desirable that prospective users of P^{32} should be aware of the severe degradation of sodium orthophosphate which occurs during neutron irradiation in the pile. If a material of definite chemical form is required it is essential to use P^{32} prepared by pile irradiation of S^{32}, and even then the identity of the active material should be confirmed before it is used.

617 Role of adrenal in uptake of I^{131} by the thyroid following parenteral administration of epinephrine. Louis J. Soffer, J. Lester Gabrilove, and Joseph W. Jailer. Proc. Soc. Exptl. Biol. Med. 71, No. 1 117-9(1949) May.

Experiments designed to investigate the role of the adrenals, in connection with increased thyroid activity after epinephrine injections, are described. The 24-hr percentage uptake of parenterally administered I^{131} was used as an index of the thyroid activity, after injections of epinephrine into intact and adrenalectomized rats. All experiments were conducted with litter mates acting as controls. The results indicate that the injection of epinephrine into intact rats results in a considerable decrease in the uptake of I^{131}. This is in sharp contrast with the results obtained in similarly treated adrenalectomized rats. In this group, the injections of epinephrine after adrenalectomy are followed by a pronounced increase in the percentage intake of radioactive iodine. It is concluded that these experiments indicate that the adrenal cortex exercises an inhibitory effect on the thyrotrophin-stimulating action of epinephrine. That the decrease in uptake of I^{131} in the epinephrine-treated intact animals is not due to the vaso-constrictor effects of the epinephrine is evidenced by the fact that in similarly treated adrenalectomized animals the percentage uptake of I^{131} is considerably greater than that of the untreated controls.

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618 Some applications of radioactive tracers in medicine. J. Rotblat. Brit. Science News 2, 201-4(1949).

A discussion of the various techniques for the use of radioisotopic tracers and their applications to research is presented. Four techniques for the measurement of the intensities of the radiations are mentioned: the sample technique; the technique of measuring radioactivity in situ; a technique involving the use of radioautographs; and a fourth technique which is an extension of the radioautograph technique, and which consists of observations of the tracks of the individual particles. The last-named technique is described in detail and an experiment involving its use is presented. After an injection of thorium B into a rabbit, drops of blood were taken at intervals and smeared over a photographic emulsion. The emulsion was then stained and developed. Alpha-particle tracks were then visible. Applications of the four techniques to the problems of tissue uptake, thyroid metabolism, diagnosis of carcinoma tissue, and other phases of research are mentioned.

619 Studies on the intra-ocular fluids. 2. The penetration of certain ions into the aqueous humour and vitreous body. Stewart Duke-Elder, H. Davson, and D. M. Maurice. Brit. J. Ophthalmol 33, 329-38(1949) June.

A detailed study of the entry of salts into the various parts of the eye from the blood is presented in which radioactive potassium and sodium (K^{42} and Na^{24}) were used as the tracers. The methods and techniques are described. In general, single intravenous injections were given followed by repeated smaller injections, but in the case of K^{42}, the rate of loss of the tracer from the blood was so rapid that a drip infusion technique was used. Thiocyanate was also tested. The results indicate that the salt content of the intra-ocular fluid is greater than can be accounted for by a process of simple ultrafiltration. Some cellular activity is, therefore, involved in the transference across the blood-aqueous barrier; a process of secretion must be postulated. The various electrolytes tested penetrate across the blood-aqueous barrier at varying rates which cannot be accounted for by a simple diffusion through inter-cellular spaces, but only by penetration through cell bodies. While some ions penetrate into the intra-ocular fluids throughout the whole of the blood-aqueous barrier, others enter the posterior segment of the cavity of the eye by way of the ciliary body.

620 Studies in iron transportation and metabolism. VII. Evidence obtained with radioactive iron that "easily split-off" blood iron is an artifact. Moisés Grinstein and Carl V. Moore. J. Clin. Invest. 28, 505-15(1949) May.

At intervals following the administration of radioactive iron to 3 normal human subjects, to 4 patients with hypochromic and pernicious anemias, and to 3 dogs made anemic by repeated bleeding, the concentration of radioactive iron in the total blood iron and in "easily split-off" iron was measured. All of the human subjects except two were given one injection of radio-iron, Fe^{59}, intravenously as ferrous ascorbate. One patient received two injections on successive days, and another patient received a mixture of Fe^{59} and Fe^{53} orally as ferrous chloride. The three dogs used in the experiment were made anemic by repeated phlebotomies prior to being given a single dose of radio-iron (a mixture of Fe^{55} and Fe^{59}) either by stomach tube or intravenously as ferric chloride. In some observations "easily split-off" iron was determined on samples of blood which had been saturated with carbon monoxide prior to the addition of acid. In one experiment, citrated blood was stored at 4°C and determinations were made at intervals for 28 days. Radioactivity appeared in the "easily split-off" blood iron fraction just as promptly and in the same concentration as it appeared in hemoglobin. No correlation was noted between the radioactivity in the "easily split-off" iron fraction and ageing of the red blood cells. It is concluded that "easily split-off" blood iron, whether determined on oxygenated blood or on blood saturated with carbon monoxide, is an artifact. 18 references. 8 figures. 3 tables.

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621 Studies on the localization of tagged methionine within the pancreas. James E. Wheeler, F. D. W. Lukens, and Paul György. Proc. Soc. Expit. Biol. Med. 70, 187-9(1949) Jan.

Methionine labelled with radioactive sulphur (S^{35}) was given intravenously to 4 cats, one normal and 3 treated so as to produce varying degrees of atrophy of the acinal tissue of the pancreas. The animals were sacrificed 8 hr after methionine was given, and various tissues were assayed for radioactive sulphur. In all animals high activity was found in pancreas, small intestine, and liver. In the atrophic portion of the pancreas where a ligature had been placed around the body of that gland, low activity was found as contrasted with high activity found in the normal part of the gland. Where atrophy was incomplete, the activity found was intermediate between that of normal and atrophic tissue. It is concluded that the high activity of radioactive sulphur found in the pancreas of normal cats after administration of labelled methionine represents principally the metabolic activity of the exocrine portion of the pancreas.

622 Studies on the metabolism of thyroxine in the body. C. P. Leblond. Ann. N. Y. Acad. Sci. 50, 444-9(1949) Jan. 27.

The preparation of radio-thyroxine and the results of the study of its metabolism in the body are presented. The radio-thyroxine was prepared by feeding rats 30-50 mc of radioiodine each, killing the rats 24 hr later, extracting the radio-thyroxine from the thyroid glands by sodium hydroxide, and purifying with alcohol. The thyroxine fraction was then injected intravenously into thyroidectomized and normal rats, and samples of the various organs, and of the blood, were taken at intervals to determine the content of thyroxine. The results are given in a table included in this paper and indicate that the thyroxine was swiftly drawn into the blood. It is concluded from the data that the liver and especially the gastro-intestinal tract play an important role in thyroxine metabolism. 20 references.

623 Studies with radioactive penicillin. D. Rowley, J. Miller, S. Rowlands, and E. Lester-Smith. Nature 161, 1009-10(1948) June 26 (Letter to the editor).

The present study was begun in order to determine if penicillin, on being absorbed, blocks the passage of glutamic acid through the cell wall. (The glutamic acid is probably essential to the life of the organisms affected by the penicillin.) Radioactive penicillin was used and was prepared by diluting 0.1 mc of S^{35} present in 0.014 mg of sulfur to a total of 0.109 mg in a 2 ml solution; after autoclaving, this medium was added to a penicillin culture, shaken for four days, and extracted. For the absorption experiments, Staphylococcus aureus was grown on agar, scraped off and transferred to 25 ml of broth, to which was added a measured amount of the radio-penicillin. After 1/2, 2, 6, and 24 hr, samples of the suspension were removed, filtered, dried, and counted. From the results of the experiment it is possible to say that absorption of penicillin amounts to less than 10 molecules per bacterium.

624 Tissue distribution of a radioactive spinal anaesthetic. Frank Howarth. Nature 163, 679-80(1949) Apr. 30 (Letter to the editor).

A preparation of radioactive anesthetic, dibromoprocaine hydrobromide with radioactive bromine incorporated into the molecule, was made from irradiated ethylene dibromide with aniline through a Szilard-Chalmer's extraction. This preparation was administered to cats by lumbar puncture and by intravenous injections in order to determine the tissue distribution of a spinal anesthetic. Doses of 0.007-0.03 g were given, and tissue samples of the skin, kidney, liver, duodenum, spleen, muscle, lung, testis, thyroid, spinal cord, spinal roots, medulla oblongata, and the sciatic nerve were taken. Blood levels were also investigated. In the intrathecal series, the blood levels were 5.4-1.3 μg/cc while in the case of the intravenous series, maximum blood levels of 44 μg/cc were noted. The tissue studies showed that apart from the spinal cord and the spinal roots, only the kidney and liver showed a concentration of the drug above that of the blood, the former reaching a maximum of 9 times and the latter 3 times the blood concentration; while their secretions, urine and bile, showed maximal concentrations

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of 133 times and 27 times that of the blood, respectively; the concentration of the drug in the duodenal contents followed that of the bile. Investigation of the faeces showed that part at least of the dibromoprocaine molecule was excreted via the gut. The spinal roots showed a higher concentration of anaesthetic per unit mass than did the cerebrospinal fluid in which they were bathed. As regards the drug content of the remaining tissues, the lung showed the highest and muscle tissue (gastrocnemius) the lowest, attaining 0.8 and 0.1 times blood concentration, respectively: the other tissues fell between these two limits. With increased time between administration and autopsy, a slight increase in the blood-tissue ratios was observed, the maximal occurring about 20 hr after administration of the spinal anaesthetic, with subsequent steady decline. Tracer could be detected in the circulation at considerable intervals (70 hr) after its administration, and, at this period, both liver and kidney concentrations were also observed to drop, in spite of a persistent blood level at which active concentrations had previously occurred.

625 Uptake of radioactive phosphorus by influenza virus. A. F. Graham and Laurella McClelland. Nature 163, 949(1949) June 18 (Letter to the editor).

To gain information about the mechanism of virus synthesis in the host cell, experiments on influenza virus were carried out in embryonated eggs in the presence of radioactive phosphorus. As a preliminary, it was necessary to determine the distribution of phosphorus in the virus. Extractions of the dried, purified virus with alcohol and ether removed about 50% of the total phosphorus (this was about 1% of the virus weight). The radioactive solution in one experiment emitted 57,000 counts/min. In experiments with P^{32}, the tracer was inoculated into the allantoic cavity of embryonated eggs 3 hr after the virus injection; the allantoic fluid was then extracted and purified 48 hr after injection, and the specific virus activity was shown to be 6.6 counts/min/μg phosphorus. An attempt was made to ascertain the activities of the pentose- and desoxy-pentosenucleic acid fraction separated in the procedure. Strong evidence was provided that the isotope was incorporated into the virus structure.

626 Use of radiopotassium for detection of minute amounts of desoxycorticosterone. Ralph I. Dorfman. Proc. Soc. Expti. Biol. Med. 70, 732-4(1949) Apr.

A preliminary report on the use of radiopotassium for the assay of the adrenal cortical hormones, with emphasis on the detection of minute quantities of desoxycorticosterone is presented. The procedure consists of subcutaneous administration of the test material in corn oil, followed one hour later by injection of potassium chloride containing radiopotassium in the amount of 10-280 μg/g of body weight. The potassium content of urine collected 6 hr after injections and dried is determined for radioactivity. The significance in the difference between injected potassium and excreted potassium is calculated. Results indicate that as little amounts as 10 μg may be detected in the adrenalectomized rats. This method, therefore, affords a convenient way to evaluate the relative activity of adrenal cortical steroids and the adrenotrophic hormone through their influence on potassium metabolism.

CHEMISTRY

627 An emanation method for radium analysis. P. Fineman, B. B. Weissbourd, H. H. Anderson, J. Sedlet, D. P. Ames, and T. P. Kohman. AECD-2620, May 3, 1946. Decl. June 10, 1949. 28p. For publication in NNES.

Apparatus and procedure for assay of radium in solution by an emanation method are described. The radon produced by the radium in a measured time is transferred with a stream of argon into an alpha ionization counting chamber. Interchangeability of emanating flasks and ionization chambers provides economy of time and apparatus and flexibility of operation. The use of a free-electron gas with a relatively low-frequency amplifier makes small amounts of electron-attaching gases and vapors in the chamber tolerable. Methods for calibration of the apparatus determination of the operating characteristics and corrections, and interpretation of results are described. Chemical procedures for obtaining solutions suitable for de-emanation from several types of radium containing materials are described.

CHEMISTRY (continued)

628 The U. S. G. S. carbonate-iodate iodine method for the determination of small amounts of thorium in naturally occurring materials. J. J. Fahey and M. D. Foster. AECD-2629, nd. Decl. June 24, 1949. 20p. For publication in NNES.

A procedure is presented for the separation and determination of very small amounts, as well as larger amounts, of thorium in naturally occurring materials. Thorium is separated by precipitation by sodium carbonate, and by potassium iodate in 3% HNO_3 solution, followed by separation from zirconium by extraction with acid in the presence of phosphate, and further precipitation as iodate. Thorium is determined colorimetrically as the iodine equivalent of thorium iodate for amounts of thorium below 0.8 mg, gravimetrically for larger amounts of thorium. A discussion of the important features of the method and the experimental work done in connection with its development are given.

629 The U. S. G. S. phosphate-fluoride-iodate method for the determination of very small amounts of thorium in naturally occurring materials. F. S. Grimaldi. AECD-2632, nd. Decl. June 24, 1949. 27p. For publication in NNES.

Detailed procedures are presented for the determination of very small percentages of thorium. The methods are designed to determine 0.001% of thorium oxide as the lower limit and are applicable to nearly all types of rocks. For quantities below a milligram of ThO_2, the thorium is determined nephelometrically as the iodate or photometrically with p-dimethylaminoazophenylarsonic acid. For quantities of thorium above one milligram of ThO_2, the thorium is determined gravimetrically. A discussion of the important features of the methods and a summary of the more important experimental work that lead to the adoption of the procedures is given.

630 A procedure for the complete electrodeposition of small amounts of ruthenium. J. C. Griess, Jr. AECU-312, May 31, 1949. 19p.

A study was made to determine the conditions necessary for complete removal of small amounts of ruthenium from solution by electrolysis. Complete deposition (> 99%) was possible when the ruthenium was present as the nitroso compound at low concentrations (5×10^{-4}M). Ruthenium metal was deposited in a smooth and adherent form on copper cathodes at cathode potentials more negative than −0.40 v vs the saturated calomel electrode. A procedure is given for the deposition of the radio-ruthenium produced at Oak Ridge National Laboratory.

631 Separation of the microscopic equilibrium of lysine by means of partition chromatography. S. Aronoff. AECU-321, nd. 1p.

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We have found that paper chromatography of lysine in a saturated phenol water system results in a plurality of spots. The number and position of these spots depends upon the pH of the aqueous solution of the lysine; their relative intensities are in general accord with the distribution of ionic species at the different pH's. The R_F's corresponding to free acid, lysinate, acid lysinate, and the free base are respectively 0.28, 0.38, 0.62, and 0.67. A slight salt effect, giving somewhat increased R_F values (e.g., 0.28 to 0.33) occurs with increasing basicity when an acid salt is used as the starting material.

As expected, the effect is absent in a basic solution, as collidine-water, or in a more economical medium which we have found equally effective for amino acid chromatography: butanol-water-pyridine (1:1:0.6). Arginine also yields long streaks rather than discrete spots in phenol, indicating a situation akin to that of lysine. The phenomenon does not appear with a polybasic amino acid as aspartic, in a basic solvent as collidine-lutidine-water. It is possible that the use of stronger bases, as the aliphatic amines, would be more effective with the weakly acidic carboxyl groups.

An explanation of the phenomenon can probably be given along lines similar to those advanced by Westall (Biochem J. 42, 249-50(1948)) for the separation of inorganic ions in partition chromatography, i.e., the basic ions are capable of association with the phenol. These compounds possess their own partition coefficients and can move independently without charging the phases.

CHEMISTRY (continued)

632 Naphthazarin as a colorimetric reagent for beryllium. W. F. Neuman and A. L. Underwood. AECU-345, May 20, 1949. 23p.

Naphthazarin has been synthesized, and studies leading to its use as a colorimetric agent for microgram quantities of beryllium are reported. From the point of view of sensitivity and accuracy, naphthazarin compares favorably with other colorimetric reagents available. From 1-20 γ of Be may be analyzed with a probable error of less than 3%. With somewhat less precision as little as 0.1 γ may be determined. Like other color-tests, the reaction is not specific for Be and numerous mineral ions have been shown to interfere.

633 Determination of C^{14} in fatty acids by direct mount technique. C. Entenman, S. R. Lerner, I. L. Chaikoff, and W. G. Dauben. Proc. Soc. Exptl. Biol. Med. 70, 364-8(1949) Feb.

A direct method for the determination of the C^{14} content in fatty acids is described, and consists of mounting fat samples directly on lens paper-covered aluminum discs in order to avoid a further dilution, such as encountered with the $BaCO_3$ method. A comparison of this method with the $BaCO_3$ method is made; the technique is described in detail and a conversion graph is included. It is stated that this method enables the operator to achieve results quickly and with no more than a 5% error.

634 A positive filter type of infrared gas analyzer. Myron A. Elliott. Naval Research Laboratory Report NRL-C-3449, Apr. 15, 1949. 15p.

A sensing unit is described for the detection of infrared absorption in the positive filter type of gas analyzer. This method uses a jet-vane system in conjunction with a photoelectric cell and a suitable amplifier for detecting the pressure unbalance between the two positive-felter detector cells. This differs from the German URAS method which uses a microphone condenser system. The construction of a working model and the results of preliminary tests on its use for carbon dioxide analysis are also described.

635 The presence and determination of molybdenum and rare earths in phosphate rock. W. O. Robinson. Soil Sci. 66, 317-22(1948) Oct.

A method for the combined determinations of molybdenum and rare earths in phosphate rock is outlined. Molybdenum was first removed by evaporation and filtration. The leached residue from the molybdenum extractions contained the rare earth elements. Phosphorus present was removed by tin, and the rare earths were then determined by two precipitations by ammonia, two precipitations with oxalic acid in very small volumes, and an intervening precipitation with ammonia. The residue was treated with an excess of KOH and the precipitate examined for rare earths. No rare earths could be detected with certainty in this precipitate. The results of the tests on rocks in different locations show that Tennessee and Island phosphate rocks are relatively low in molybdenum while Florida phosphate rocks and North African rocks are generally higher, more than 20 ppm. Some western phosphate rocks are very high in molybdenum. Superphosphate retains the molybdenum originally in the phosphate rock. Rare earths were present in phosphate rocks in concentrations of 110-1,550 ppm R_2O_3 (rare earths) in the samples examined.

636 Radiochemical activity analysis. David N. Hume. Analyt. Chem. 21, 322-6(1949) Mar.

Radiochemical activity analysis is defined as the identification and determination of the radioactivity due to individual constituents in mixtures of radioactive materials. Physical methods of identification of individual radioactivities and chemical methods for the resolution of mixtures are described. Addition of a known amount of inactive carrier and determination of the efficiency of recovery of the isolation process permit short-cut methods to be used in quantitative determinations and greatly cut the time necessary for an analysis. Methods for the rapid determination of radioactivity due to each of the fission elements have been developed and the procedure for zirconium activity is discussed in detail. Applications in radioactive tracer production and utilization are suggested.

CHEMISTRY (continued)

637 Report on spectrophotometric determination of titanium in steels. A. Weissler. Naval Research Laboratory Report No. NRL-M-2436, Dec. 30, 1944. 36p.

Investigation of the effect of metallic and combined titanium on the hardenability of steel caused a search for an accurate, rapid, reproducible method of chemical analysis for these two constituents. In order to make certain of the validity of the procedure developed, it was necessary to study such variables as acid concentration and effects of diverse ions. The report presents methods for the hydrogen peroxide spectrophotometric determination of titanium in iron, steel, vanadium steel, and stainless steel, which involve no separations of the titanium or bleaching with hydrofluoric acid. Also included are the absorption spectra on which these methods are based. 30 references.

638 Isotope effect in the rupture of carbon-carbon bonds in propane-1C^{13}. Jacob Bigeleison. AECU-256, nd. 3p.

The upper limits for the ratios of the rate constants in the rupture of C-C bonds in propane have been calculated for the following elementary pyrolysis reactions:

$$C^{12}H_3\text{-}C^{12}H_2\text{-}C^{12}H_3 \xrightarrow{k_1} C^{12}H_3 + C^{12}H_3\,C^{12}H_2$$

$$C^{12}H_3\text{-}C^{12}H_2\text{-}C^{13}H_3 \xrightarrow{k_2} C^{13}H_3 + C^{12}H_3\,C^{12}H_2$$

$$C^{12}H_3\text{-}C^{12}H_2\text{-}C^{13}H_3 \xrightarrow{k_3} C^{12}H_3 + C^{13}H_3\,C^{12}H_2$$

The ratio of the several rate constants were calculated using an approximate equation derived by the application of the statistical mechanical treatment of isotopic molecules to the statistical treatment of absolute rates. The results are given in the following table:

T°K	$k_1/2k_2$	$k_1/2k_3$
300	1.043	1.023
400	1.034	1.014
500	1.030	1.010
800	1.024	1.004

639 Preparation of $H_3B^{10}O_3$ from B^{10}. Paul C. Tompkins. AECU-318, June 15, 1949. 8p.

B^{10} proved to be resistant to solution by concentrated HNO_3, fuming HNO_3, Br_2, and concentrated $H_2SO_4 + K_2S_2O_8$ but was slowly dissolved by long refluxing with aqua regia. The reflux was used to prevent losses of H_3BO_3 by volatilization. The acid was diluted with water and any solid particles removed by filtration. The excess acids were then distilled off and volatized H_3BO_3 recovered by redistillation. The second distillate was evaporated over a steam bath since any loss of $H_3B^{10}O_3$ by volatility from this solution was considered to represent a negligible fraction of the total material. It was found that when aqua regia was added to a small quantity of the boron (100 mg), the oxidation was very slow and the material was refluxed for 5 hr in the presence of excess aqua regia (30 ml) to obtain complete solution. However, when 30 ml of aqua regia was added to the main sample (10 gms) at room temperature, a slight reaction started at once. In a period of 5 min, the reaction became so violent that it was necessary to cool the reaction vessel. Apparently, local superheating occurred in the interior of the sample. When this stage was passed, it did not recur on the application of heat to the reaction vessel. The details of the procedure outlined above are given in a flow sheet.

640 Comparative studies of gallium chemistry, April 1 to June 1, 1949. University of Illinois Bimonthly Report No. 12, nd. 11p. (NP-897).

The hydrolysis studies outlined in previous reports have been made on solutions of gallium tribromide. Using calculations based on the assumptions previously outlined, an average hydrolysis constant of 4.0×10^4 was obtained over the concentration range 0.010 to 0.400 M gallium ion.

CHEMISTRY (continued)

Electrometric titrations with standard alkali were carried out on solutions of gallium tribromide and thallium trichloride. For the gallium tribromide solutions precipitation incidence of the hydrous oxide was noted at a mole ratio of added hydroxyl ion to gallium ion approximating 3.0 and at about a pH of 5.0. From thallium trichloride solutions thallium (III) oxide was precipitated at an average pH of 3.28 and at a mole ratio of about 0.65. Also during this time some preliminary experiments on the polarography of the tripositive gallium ion have been carried out with the hope that ultimately this method might give some insight into the nature of the species existing in a solution of a gallium salt to which an insufficient quantity of hydroxyl ion to precipitate the hydrous oxide has been added. The high temperature reactions between gallium oxide and other more basic oxides have been continued. Magnesium gallate has definitely been obtained by heating a mole-to-mole mixture of magnesium oxide and gallium oxide for 5 1/2 hours at 1300°C.

641 Electrolytic deposits of Po in extremely dilute solutions. M. Haissinsky, H. Faraggi, A. Coche, and P. Avignon. Phys. Rev. 75, 1963-4(1949) June 15 (Letter to the editor).

Some observations on the electrolytic deposit of Po in extremely dilute solutions (10^{-10} - 10^{-14}N) are described which seem to indicate that a fraction of the Po atoms slightly penetrates the interior of the metal, and a partial absorption of α-rays with a shortening of their range occurs. The significance of this, in terms of the surface structure, is discussed. It is also noted that the results obtained explain the results recently obtained by Chang (Phys. Rev. 69, 60(1946)). The numerous groups of "reduced" tracks of α-particles observed by Chang are probably related to the ultra-fine structure of the surface, rather than to the fine-structure of the α-rays.

642 The isotope effect in the decomposition of oxalic acid. J. G. Lindsay, D. E. McElcheran, and H. G. Thode. J. Chem. Phys. 17, 589(1949) June (Letter to the editor).

The decomposition of oxalic acid into CO, CO_2, and H_2O in the presence of concentrated sulfuric acid has been studied; variations in the natural C^{13} content of the oxalic acid and products were measured to determine the isotope effect. This procedure eliminates the necessity of synthesizing labeled materials and reduces certain contamination problems. Two effects were observed: (1) a preference for the C^{13} to appear in the CO_2 rather than the CO and (2) a higher rate of decomposition of oxalic acid molecules containing only C^{12} carbon atoms over those containing C^{13} atoms. The isotope effect on the specific rate constants is evaluated and found to be 3.5%. The fact that C^{13} is favored in the CO_2 seems to indicate a preferential splitting of the $C^{12} - O^{16}$ bond over that of the $C^{13} - O^{16}$ bond, although it seems likely that the C - C bond is also involved because of the second isotope effect. Further experiments are in progress to determine also the distribution of O^{18} between the products of the reaction.

643 Laboratory exercises in nuclear chemistry. Parts I and II. Russell R. Williams, Jr., William H. Hamill, and Robert H. Schuler. J. Chem. Education 26, 210-15, 218, and 310-15(1949) Apr. and June.

Some of the general principles necessary to an understanding of nuclear chemistry are presented in Part I. These include discussions of the following: (1) preparation and characteristics of radioactive tracers; (2) physical operations (slow neutron activation, the Geiger counter, activity determinations); and (3) chemical operations (isotopic exchange and the Szilard-Chalmers reaction). In the second article of the series a group of experiments designed to demonstrate some of the fundamental physical operations necessary to nuclear chemistry are described. These fall into three groups: (1) characteristics of the Geiger tube; (2) factors involved in determining the activity of a radioactive sample; and (3) activation by slow neutron bombardment.

CHEMISTRY (continued)

644 Preparation of cystine from radioactive sulfur. John L. Wood and L. Van Middlesworth. J. Biol. Chem. 179, 529-33(1949) June.

A method for the preparation of cystine labeled with radioactive sulfur, S^{35}, is presented. The experimental data concerned with the preparation and the investigation of α-amino-β-chloropropionic acid, benzyl-DL-cysteine, S-benzyl-L-cysteine, and L-cystine are included. The benzyl-DL-cysteine preparation which this paper describes, may be converted to optically inactive cystine, or resolved into benzyl-L- and benzyl-D-cysteine. 14 references.

645 Preparation and properties of tridecanoic acid containing C^{14} in the carboxyl group. Edward Hines and Andrew Gemant. Science 110, 19(1949) July 1.

The preparation of radioactive tridecanoic acid, an organic electrolyte to be used in the study of mobilities and the molecular sizes of ion-forming compounds in dielectric fluid, is described. The tridecanoic acid was prepared by the Grignard reaction from lauryl bromide and carbon dioxide, the carbon dioxide being obtained by the acidification of barium carbonate containing C^{14} in the carboxyl group. This experiment necessitated the use of an excess of Grignard reagent. The purification from secondary products was carried out by saponification and reprecipitation of the acid. The properties of the acid and the apparatus used in the synthesis are described. Computations for the theoretical and actual radioactivity of the acid are included.

646 Radioactive diisopropyl fluorophosphonate. B. C. Saunders and T. S. Worthy. Nature 163, 797-8(1949) May.

A direct method for the preparation of radioactive diisopropyl fluorophosphonate is presented which entails the use of modified apparatus and techniques. P^{32} is converted into phosphorus trichloride, and then into diisopropyl hydrogen phosphite; this product is converted through the chlorophosphonate stage to the fluorophosphonate. It is considered that this direct method has advantages over the indirect method.

647 Radioactive L-cystine and D-methionine. A study of the resolution of radioactive racemates by isotopic dilution. John L. Wood and Helmut R. Gutmann. J. Biol. Chem. 179, 535-42(1949) June.

A procedure for the resolution of radioactive racemates based on isotope dilution has been applied to the preparation of radioactive L-cystine and radioactive D-methionine through the use of S^{35}. Radioactive benzyl-DL-cysteine diluted with unlabeled benzyl-L-cysteine was resolved to radioactive benzyl-L-cysteine by fractional recrystallizations. The progress of the resolution was followed by measurements of the specific radioactivity in successive fractions. Crystallization to constant specific radioactivity and conversion of the last fraction to optically pure, radioactive L-cystine or radioactive N-acetyl-S-benzyl-L-cysteine with no change in the specific radioactivity indicated that the resolution was complete. The resolution of radioactive benzyl-DL-homocysteine, an intermediate in the synthesis of methionine, to radioactive benzyl-D-homocysteine was accomplished by the same method. Conversion of the last fraction to the acetyl derivative and recrystallization of the derivative without change in the specific radioactivity indicated that complete resolution to benzyl-D-homocysteine had been achieved.

648 Thorium nitrate. III. The distribution of thorium nitrate between water and certain esters and the nature of the distribution equilibrium. Charles C. Templeton, Bill F. Rothschild, and Norris F. Hall. J. Phys. & Colloid Chem. 53, 838-45(1949) June.

Ethyl butyrate shows about the same properties for the solvent extraction of thorium nitrate from aqueous solution as alcohols and ketones of comparable molecular weight. Ethyl acetate was found to be miscible with aqueous solutions containing appreciable amounts of thorium nitrate, and therefore to

CHEMISTRY (continued)

be unsuitable as an extractant in the concentrated range. It has been shown that the effect of added nitric acid on the distribution of thorium nitrate between water and an organic solvent lends support to the view that the salt is more or less completely ionized in aqueous solution, and undissociated in the organic phase.

649 The crystal structure of sodium superoxide. David H. Templeton and Carol H. Dauben. AECU-278, June 15, 1949. 17p.

The crystal structure of sodium superoxide has a face-centered cubic lattice with a = 5.490 ± 0.005 A. The structure is like that of sodium chloride with O_2 ions occupying halide positions with disorderly orientation. The bond distance in the superoxide ion in this crystal is 1.33 ± 0.06 A.

650 Structure of ferroelectric $BaTiO_3$. G. C. Danielson and R. E. Rundle. AECU-313, nd. 1p.

This document is in abstract form; it is reproduced below in its entirety.

Megaw (Proc. Roy. Soc. (London)189, 261(1947)) has shown from x-ray powder photographs that $BaTiO_3$ is tetragonal in the ferroelectric state with unit cell dimensions at 20°C of a_o = 3.9946 A, c_o = 4.0335 A. It has been reported by one of us (Danielson, et. al., Phys. Rev. 74, 986(1948)) that x-ray diffraction of a single domain crystal at 20°C indicates that the titanium ion is displaced from the center of the unit cell and in the direction of the c axis by about 0.16A, in agreement with the displacement to be expected from Hulm's measurement (Nature 160, 126(1947)) of the spontaneous polarization. Recently Mason and Matthias (Phys. Rev. 74, 1622(1948)) have made reference to this displacement of the titanium ion in developing a theory to explain the ferroelectric behavior of $BaTiO_3$. The previous x-ray determination was based on the relatively high intensity of x-ray scattering from the (00 11) plane as shown by Weissenberg pattern using molybdenum radiation. The interpretation of this high intensity is open to question, however. By using Ag radiation from a demountable gas tube, and single domain crystals grown by E. G. Grimsal and F. A. Halden (using Matthias' method), it now appears that the displacement of the titanium ion must be much less than previously reported and even less than 0.1 A at 20°C. Still shorter wavelength radiation seems to be necessary for an exact determination.

651 On the isomorphism of alkaline perchlorates. Georges Kayas. Compt. rend. 228, 316-7(1949) Jan. 24 (in French).

The Mitscherlich law was tested for the case when one of the components is present in imponderable quantities. Potassium perchlorate contained traces of radioactive sodium perchlorate in which Na^{22} originated from the irradiation of Mg by deuterons. Notwithstanding numerous leachings with alcohol to remove the sodium salt, the activity of the remaining crystals persisted, (0.18 Geiger-Müller pulses/mg/min). Through fractional crystallization the activity gradually increased up to 31.5 pulses/mg/min; the rate of the increase showed that the mixture behaved like a single phase. The law of isomorphism includes cases defined above, at least for the system $KClO_4 - KNaO_4$.

652 The refinement of atomic parameters by the technique known in x-ray crystallography as "the method of steepest descents." A. D. Booth. Proc. Roy. Soc. (London) 197A, 336-55(1949) June 22.

A discussion of the normal methods of structure analysis results in a formulation of the problem as one of minimization, and leads naturally to the idea of optimum procedures for this purpose. Three techniques are derived from a unified presentation: (1) the 'relaxation' method, (2) the 'least squares' refinement, and (3) the method of 'steepest descents.' These are examined in detail and their virtues and defects noted. A complete discussion of the application of the steepest descent procedure to various types of structure analysis is given and techniques are derived for the cases of: refinement of a set of parameters already reasonably good; refinement of a structure where general configuration but not

CHEMISTRY (continued)

orientation is known; and refinement of structures given by electron densities on a lattice. Several variants of the process are given, in one of which only those planes of zero observed intensity being used; this gives a process which is independent of phase angle values and should be useful in the case of structures for which no chemical data is available.

653 The vibrational spectra of molecules and complex ions in crystals. I. General theory. Donald Hornig. Office of Naval Research Technical Report No. 3, May 20, 1948. 39p. (NP-855).

It is shown that if a crystal is approximated as a harmonic oscillator only a very small number of vibrational modes may be active in the infrared or Raman spectra. These modes are all totally symmetric with respect to translation. They must also have proper symmetry with respect to the factor group of the space group which we have called the unit cell group. The active frequencies may be calculated from a single unit cell. It is shown further that the number and symmetry type of vibrational modes may be correctly calculated from the local symmetry (site group) of the center of gravity of each kind of molecule. In the harmonic approximation the spectrum should consist of very sharp lines. The wide bands obtained experimentally are probably due to combination lines with lattice vibrations and indicate an harmonic coupling between molecular and lattice modes. Such combinations may cause apparent violations of selection rules for internal vibrations. The symmetry basis for obtaining selection rules in this case is given. The importance of obtaining spectra over a wide temperature range and particularly a very low temperature is emphasized. In cases where all internal modes have a frequency great compared to the frequency of lattice modes, the problem is examined from the point of view of the Born-Oppenheimer approximation. It is shown that for some symmetries perturbations linear in the lattice displacement may occur. In these cases considerable splitting of degenerate molecular vibrational modes is possible. Groups for which first order splitting is not expected are listed. Symmetry species of other groups are classified into those which may and which may not be split in this approximation and the lattice modes responsible for splitting are classified as rotations or translations and by symmetry type.

654 The infrared absorption spectra of propane-D-1 and propane-D-2. L. Friedman and J. Turkevich. AECU-279, nd. 14p.

An investigation of the infrared absorption spectra of propane-D-1 and propane-D-2 was undertaken in an attempt to determine the precise position of the vibrational frequencies of the isolated primary and secondary carbon-deuterium bonds. Interest in these frequencies was based mainly on the need for an analytical method for the determination of the distribution of deuterium in isotopically substituted hydrocarbons (Turkevich, et. al., J. Am. Chem. Soc. 70, 2638(1948)). A difference in the position of the primary and secondary C-D stretching frequencies is reported. This difference places the secondary C-D frequency 45 $cm^{-1} \pm 5\ cm^{-1}$ lower than the corresponding primary C-D vibration.

655 Isotopic weight doublet in the $B_2{}^{11}D_6$ and O_2 mass spectrum. Francis J. Norton. Phys. Rev. 75, 1957(1949) June 15 (Letter to the editor).

An instance in which resolution within a single mass peak was observed using a mass spectrometer is described. Since the isotopic weight of the $B_2{}^{11}D_5{}^+$ ion is 32.0994 while that of the $O_2{}^{16}{}^+$ ion is 32.0000, this large difference of nearly 10% of a mass unit was indicated by a doublet in the mass 32 peak which was observed for partially deuterated diborane $B_2{}^{11}D_6$, in the presence of a small amount of air.

656 Effects of cold rolling on the transparency and other physical properties of fluorothene. W. J. Laird, R. D. Anding, and E. R. Lady. AECU-277, June 24, 1949. 30p.

The transparency of fluorothene sheets was increased by compression rolling. However, fluorothene must be reduced to one half its original thickness by rolling before it becomes more transparent

CHEMISTRY (continued)

than fluorothene molded to the same thickness. The fluorothene sheets which exhibit the greatest transparency when reduced in thickness by cold rolling are those which have been cold quenched. Cold rolling decreases both the hardness and the density of fluorothene. The transparency of cold rolled fluorothene is reduced on continued exposure to temperatures over 75°C.

657 Correlation of critical temperatures with thermal expansion coefficients of liquid fluorocarbons. G. P. Rutledge. AECU-295, June 13, 1949. 17p.

The critical temperatures of decafluorobis(trifluoromethyl)cyclohexane, dichlorooctafluorobis (trifluoromethyl)cyclohexane, undecafluoro(trifluoromethyl)cyclohexane, bis(trifluoromethyl)benzene, and hexadecafluoroheptane are predicted from thermal expansion data to be 240.1, 334.1, 207.4, 276.4, and 194.9°C, respectively. These predicted values when compared with experimentally determined critical temperatures show an agreement within 2%.

658 Physical properties of chlorotrifluoroethylene polymers. IV. The refractive indices of chlorotrifluoroethylene polymers and the correlation of this property with densities, viscosities, molecular weights, and structure indications. J. L. Gabbard, S. Blumkin, and E. S. Amis. AECU-300, May 20, 1949. 37p.

The determination of the refractive indices of chlorotrifluoroethylene liquid polymers was made as a continuation of the studies reported in the earlier papers of this series. The refractive indices of the chlorotrifluoroethylene polymers may be represented as a linear function of temperature between 27.5 and 60.0°C. The refractive index-temperature coefficients of the polymers vary inversely as some function of their molecular weights. The correlation of the refractive indices with the densities, viscosities, and molecular weights is very good for the fractions of a single lot, but is different from lot to lot. The density and the logarithm of the molecular weight are each a linear function of the refractive index, and the logarithm of the logarithm of the viscosity a parabolic one. The use of the molar refraction data to ascertain the end group composition and structure of the polymers leads to the conclusion that the polymer chains are terminated by a variety of end groups and that each lot contains these in somewhat different proportions. To this may be added the indications of isomerism or small differences in composition within the polymer chains.

659 Effect of agitation on the low-temperature polymerization of chlorotrifluoroethylene. W. H. Reysen, K. E. Rapp, Jr., D. S. Napolitan, and J. D. Gibson. AECU-308, June 17, 1949. 18p.

A systematic investigation has been made of the variables involved in the low-temperature polymerization of chlorotrifluoroethylene to a plastic polymer (Fluorothene). Emphasis has been placed on the factors involved in developing a continuous process, giving special consideration to the effect of agitation, a variable which is inherently associated with this problem. In all cases where agitation was employed yields were greater, but No-Strength-Temperature values were correspondingly lower. Although many of these data are empirical and are not expected to be quantitatively valid under conditions where larger or different-type reactors are used, it is sufficient to show that a continuous process is possible for the preparation of Fluorothene in the melt-viscosity range of commercially produced polychlorotrifluoroethylene plastic.

660 Phase equilibria between fluorothene and solvents. R. E. McHenry, S. E. Frey, J. D. Gibson, and R. H. Lafferty, Jr. AECU-311, May 20, 1949. 15p. Proposed for publication in Ind. Eng. Chem.

An investigation of the phase equilibria between Fluorothene (solid chlorotrifluoroethylene polymer) and a number of high boiling solvents was made for the purpose of finding a good solvent for Fluorothene. Of the reagents tested, chlorotrifluoroethylene liquid polymers were found to be the best solvent. No solvent had appreciable effect on Fluorothene at temperatures much below its transition point, about 218°C. For Fluorothene an increase in molecular weight had little effect on solubility. For low molecular weight chlorotrifluoroethylene liquid polymer, an increase in molecular weight caused a decrease in solubility.

CHEMISTRY (continued)

661 Graphite characteristics. F. D. Bender. AECU-296, Apr. 20, 1949. 6p.

A comparison was made to evaluate various types of graphite. Tensile, compressive, density, and permeability tests and chemical analyses were conducted on a limited number of types of commercial graphite. Results appear erratic and uncorrelated and suggest a great dissimilarity between samples of the same type as well as between different types.

662 Apparatus and method for determining gas permeability of carbon and graphite. S. D. Fulkerson and E. J. Lambert. AECU-297, Feb. 21, 1949. 11p.

The construction and operation of an apparatus for determining the gas permeability of carbon and graphite is described. The apparatus is built almost entirely of pyrex, is light, portable, and inexpensive. The results are accurate, and can be expressed in direct units or as comparative results. Possible adoption as a standard apparatus is suggested.

663 On the oxidizing and reducing actions of α- and x-radiations. Moïse Haïssinsky and Marc Lefort. Compt. rend. 228, 314-6(1949) Jan. 24 (in French).

A study was made of the oxidizing and reducing properties of radiations, as a function of such factors as the nature of the radiation, the dose absorbed, the pH, the concentration, and the temperature of the solution, the nature of the solvent, the presence of oxygen, etc. The radiations used were α-particles (from radon) and x-rays. The reactions studied were the oxidation of KI into I_2, that of KNO_2 into KNO_3, and the reverse reactions; the reduction of KIO_3. The general conclusion was that there exist considerable qualitative and quantitative differences between the action of strongly ionizing particles and that of x-rays; it was also observed that in the majority of cases the oxidations occur more readily than the reductions.

664 The absorption spectra of the rare earths and their significance for the investigation of the emission spectra in general. Wilhelm Prandtl. Naturw. Rundschau 2, 57-60 (1949) Feb. (in German).

The author's determination of the absorption spectra of rare earths, an outcome of 25 years' work, is presented in a table. The absorption spectra do not show the sharpness and constancy of lines characteristic of emission spectra; absorption maxima can seldom be determined within 1 - 2 A. On the other hand, the line number is incomparably smaller: cerium, praseodymium, and neodymium, whose emission spectra show 3207, 2515, and 2927 lines, respectively, present absorption spectra with only 3, 5, and 37 maxima. This last circumstance permitted the author to attempt an empirical search for regularities, such as repeatedly occurring units whose multiples form wavelengths or differences between wavelengths. Two such units were found: $3 \times 17 \times 31 \times 40^{-1} = 39.525$ and $3 \times 17^2 \times 100^{-1} = 8.67$. Numerous examples are given of the occurence of multiples of these units not only in the absorption spectra of the rare earths, but also in their emission spectra. In the author's opinion, the spectra of all other elements should be tested for the occurrence of these, and possibly other, units. On the basis of the statistics obtained, a theory could be attempted revealing the physical meaning of these natural units.

665 Crystal chemical studies of the 5f-series of elements. Part VI. The Ce_2S_3-Ce_3S_4 type of structure. W. H. Zachariasen. Acta Cryst. 2, 57-60(1949) Mar.

The compounds Ce_2S_3, La_2S_3, Pu_2S_3, Ac_2S_3 and Am_2S_3 are shown to be iso-structural. The structure is cubic with 16 sulfur atoms and 10 2/3 metal atoms per unit cube, and the unit-cell constant for the prototypic compound Ce_2S_3 is $a = 8.6173 \pm 0.0005$ kX. The metal atoms are randomly distributed over 12-fold positions such that on the average every ninth site is vacant. The space group is

CHEMISTRY (continued)

$I\bar{4}3d$-T_d^6 and the atomic positions are:

(0,0,0), $(\frac{1}{2},\frac{1}{2},\frac{1}{2})$ +; 10 $\frac{1}{2}$ Ce in $(\frac{1}{4},\frac{1}{4},0)$D; $(\frac{3}{4},\frac{1}{4},0)$D.

16 S in (x,x,x); $(x+[\frac{1}{2}],[\frac{1}{2}]-x,\bar{x}$D; $(x+[\frac{1}{2}],x+[\frac{1}{2}],x+[\frac{1}{2}])$; $([\frac{3}{4}]+x,[\frac{1}{4}]-x,[\frac{1}{4}]-x$D;

with x + 0.083 ± 0.015.

For Ce_2S_3 the homogeneity range of the phase extends to the composition Ce_3S_4 corresponding to all metal sites being filled.

666 Crystal chemical studies of the 5f-series of elements. Part VII. The crystal structure of Ce_2O_2S, La_2O_2S and Pu_2O_2S. W. H. Zachariasen. Acta Cryst. 2, 60-2(1949) Mar.

The compounds Ce_2O_2S, La_2O_2S and Pu_2O_2S are isostructural, with one stoichiometric molecule per hexagonal unit cell. The unit-cell dimensions for the prototypic compound Ce_2O_2S are:

a_1 = 4.00 ± 0.01 kX.; a_3 = 6.82 ± 0.03 kX.

The space group is $C\bar{3}m$ and the atomic positions are:

2 Ce in ± $(\frac{1}{3}, \frac{2}{3}, u_1)$, with u_1 = 0.29 ± 0.02;

1 S in (0, 0, 0);

2 O in ± $(\frac{1}{3}, \frac{2}{3}, u_2)$, with u_2 = 0.64.

The structure is closely related to that of Ce_2O_3 (D 52 type).

667 On formation of complex compounds by rare earth elements. D. I. Ryabchikov and E. A. Terent'eva. Izvest. Akad. Nauk. S. S. S. R. Otd. Khim. Nauk. 44-55 (1949) Jan.-Feb. (in Russian).

It was found that in the group of rare earth elements the readiness to form stable complex compounds grows with the decreasing ionic radius. Unlike many heavy elements, the rare earths do not enter into a non-ionogenic combinations with such strong substitution groups as $S_2O_3^{--}$, J^-, CN^-, NO_2^-, and NH_3. A series of complex compounds with amines and organic-acid salts was isolated. 29 references.

668 Fluorescence spectra of solid materials obtained by a modification of the Beckman spectrophotometer. Alfred A. Schiller and Louis P. Cecchini. Naval Medical Research Institute Report NM-001-008 No. 2., July 20, 1948. 22p.

An apparatus and procedure which permits utilization of the Beckman spectrophotometer for precision analyses of fluorescent radiation is described. The color and luminosity properties of a number of fluorescent signal fabrics against aluminum and brass backings and after prolonged ultraviolet irradiation have been determined. The fluorescence of each type of fabric was shown to have a high degree of monochromaticity. The luminosities of the fabrics were variable and not related to their color characteristics. The aluminum backing increased the luminous output in the majority of cases, whereas prolonged UV irradiation was found to significantly suppress luminosity. Discrepancies in color designation by manufacturers and wide variations in luminosity among the fabrics examined require that a systematic standardization of fluorescent materials used in visual communications be made.

CHEMISTRY (continued)

669 Isotope shift in the helium spectrum. Mark Fred, Frank S. Tomkins, and James K. Brody. Phys. Rev. 75, 1772-3(1949) June 1 (Letter to the editor).

The He^3-He^4 shifts of a number of lines in the helium spectrum have been determined. The results obtained are compared in tabular form with the theoretical shifts as calculated by Eckart (Phys. Rev. 36, 878(1930)). The discrepancies observed are much larger than the estimated errors and it is noted that the deviations for successive series members decreases and appears to approach zero at the limit. This suggests that the calculated P shifts are valid and that the S and D shifts are incorrect. From the data the term shifts have been calculated and tabulated. In a discussion of the term shift data, it is noted that the shifts $\Delta T = T^{(4)} - T^{(3)}$ of the S and D levels may be represented by

$$\Delta T = (\Delta\mu/m)T \pm 4.77 \times 10^{-4}(2S + 1)T^{1/2},$$

where the plus sign applies to the triplets and the minus sign to the singlets.

670 Microwave spectroscopy in the region of three to five millimeters. Alex. G. Smith, Walter Gordy, James W. Simmons, and William V. Smith. Phys. Rev. 75, 260-3(1949) Jan. 15.

Exploratory investigations in the region of the electromagnetic spectrum between 3.3- and 5-mm wavelength have shown that useful work can be done here with available sources and detectors. Higher rotational transitions of BrCN and ICN have been observed with satisfactory signal-to-noise ratios at pressures low enough to resolve the nuclear quadrupole splittings. These measurements indicate that the minimum detectable absorption is 10^{-5} neper/cm with the present spectroscope. The B_0 value of HCN has been determined as 1.4789 cm^{-1}, in agreement with infrared results. The quadrupole coupling factor for the nitrogen nucleus in this molecule has been found to be 4.7 mc.

671 The validity of the use of tracers to follow chemical reactions. Jacob Bigeleisen. AECU-257, nd. 7p

In the use of tracers, either stable or radioactive, it is important to know how large the differences in chemical properties between the isotopic molecules are. The thermodynamic properties of systems containing isotopic molecules in chemical equilibrium can be calculated by simple formulae (J. Bigeleisen and M. G. Mayer, J. Chem. Phys. 15, 261(1947)). In many cases the isotopic molecules are not in equilibrium with respect to various exchange reactions. In such cases it is important to know whether the specific activity of the product of some chemical transformation of the substrate isotopic molecules is the same as the initial specific activity or not. If the initial specific activity is known, then the specific activity of the product can be calculated by integration of the rate equations for the respective reactions. In this paper changes in the specific activity by radioactive decay or other nuclear processes are neglected. Equations are derived for estimating the upper limits of the ratio of the rate constants for reactions involving isotopes. These values are tabulated for 22 common tracer isotopes.

672 The exchange reaction between the two oxidation states of cerium in nitric acid solutions. J. W. Gryder and R. W. Dodson. AECU-331, nd. 2p.

In this preliminary report measurements are given on the rate of exchange between cerous and ceric ions in nitric acid solution using Ce^{144} as a tracer. Several experiments were performed in which a diffusion separation was employed. The results indicated complete exchange within 2 hr, but the poor separation factor and the possibility of reduction of ceric ion in the diffusate indicated that another approach would be desirable. The second method employed was to extract ceric cerium from nitric acid solution with diethyl ether. Stock solutions of active cerous and inactive ceric nitrates were mixed in a thermostated bath, and the ceric nitrate was extracted into analytical reagent ether. The resultant solution was diluted to constant volume and counted with a dipping Geiger-Müller tube. It was found that no significant amount of cerous ion is extracted and that the extraction of ceric nitrate is essentially complete.

CHEMISTRY (continued)

The results of measurement made under various conditions are given tabular form. Ceric concentration was determined by titration with ferrous ion. Cerous concentration was determined by this titration after first oxidizing the sample with ammonium peroxysulfate and silver catalyst. From these data it is calculated that the experimental energy of activation is 13.4 ± 0.7 kcal; it is concluded that the reaction is first order with respect to both cerous and ceric concentrations.

673 A method of estimating and minimizing the error of measurement of the rate of a radioactive exchange reaction. Norman Davidson and John H. Sullivan. J. Amer. Chem. Soc. 71, 739-40(1949) Feb.

A method is presented for the estimation of the error in the rate constant for the radioactive exchange reaction, as a function of the extent of exchange. This error may be due to statistical counting errors or to manipulative errors in preparing chemically identical samples for radioassay. A graphical method permits the selection of the optimum degree of exchange to minimize the error in the rate constant.

674 Radioactive isotopes as tracers. Peter E. Yankwich. Analyt. Chem. 21, 318-21(1949) Mar.

The applications of radioisotopes in analytical chemistry as tracers and near-tracers are considered. The latter classification includes cases in which the isotopes differ somewhat from the normal mixture of stable isotopes in their properties. Thus, radioactive isotopes as applied in diffusion-like processes (particularly isotopes of the lighter elements) are probably not true tracers. The following topics are treated: (1) the technique of isotope dilution analysis by means of tracers; (2) a series of steps as a means of establishing the identity and purity of a known compound in a complex mixture; and (3) the use of isotope effects on reaction rates. 21 references.

675 A study of the mechanism of some chemical reactions by the isotope method. A. I. Brodskiĭ. Izvest. Akad. Nauk S.S.S.R. Otd. Khim. Nauk, 3-12(1949) Jan.-Feb. (in Russian).

A short account is given of the results of several investigations, made in author's laboratory, on reactions of isotopic exchange (hydrogen exchange in derivatives of toluol; some cases of oxygen exchange) and of group rearrangements (Beckman's reaction, tautomery of toluol, hydrogen rearrangement in phenols). 26 references, of which 12 are Russian.

676 Use of deuterium in the study of the mechanism of reactions of organic compounds. G. P. Miklukhin. Uspekhi Khim. 18, 237-60(1949) Mar.-Apr. (in Russian).

A review of works on the applications of deuterium as an indicator in organic chemistry. 228 references, mostly American; also British, German, and Japanese; 35 are Russian. The following reactions are surveyed: Tautomeric transformations, krypto-tautomeric phenomena, cis-trans-isomerization, electrochemical Kolbe synthesis, Canizzaro's reaction, tranformations of glucose in alkaline solutions, polymerization of unsaturated hydrocarbons, action of H_2O_2 on formaldehyde, formation of chloroform from chloral, rearrangements between amino-acids and amino-ketones, exchanges of radicals, hydrogen rearrangements in phenols, Claisen's rearrangement, thermal disintegration of acetaldehyde, catalytic hydrogenation of aldehydes and ketones.

677 New crystal structures. II. W. H. Zachariasen. AECD-2628, Apr. 15, 1949. Decl. June 17, 1949. 1p.

This document is in abstract form; it is reproduced below in its entirety.

1. Two new compounds with sodium chloride type of structure have been identified. The compounds are AmO and NpN. The unit cell constants are:

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	a
AmO*	4.95 ± 0.01 kX
NpN	4.887 ± 0.002 kX

*Degree of purity uncertain

2. An x-ray diffraction pattern of protactinium oxide preparation showed fluorite type of structure with a = 5.45 ± 0.01 kX. A unit cell of a = 5.51 kX is expected on the basis of interpolation between ThO_2 and UO_2. It is suggested that the protactinium oxide has composition in $PaO_{2.2}$, i.e., that the reduction to the tetravalent state is incomplete.

3. The compounds NpO_2F_2 is found to be isostructural with UO_2F_2. The rhombohedral cell containing one molecule has dimensions a = 5.784 kX, $\alpha = 42°16^1 \pm 10^1$.

678 The eight new synthetic elements. Glenn T. Seaborg. Naturw. Rundschau 2, 93-7(1949) Mar. (in German).

This is an abridged translation of an article published in Am. Scientist 36, 361(1948). The question is discussed of the possible existence in nature of the elements 43, 61, 85, and 87. The history of the synthetic preparation of these 4 elements is outlined. The discovery of the transuranic elements 93, 94, 95, and 96 is related.

679 Analytical chemistry of the Manhattan Project. NNES, Div VIII, Vol I, Chap 25. Electrometric methods, apparatus, and technique. N. H. Furman and J. I. Watters. AECD-2623, nd. Decl. June 2, 1949. 75p. For publication in NNES.

The general principles and techniques of potentiometric methods are briefly surveyed, and a description of potentiometric apparatus is given. The potentiometric titration of uranium is discussed in detail. General polarographic methods and apparatus are also surveyed; detailed polarographic methods for the analysis of uranium are given. Conductrimetric methods are briefly discussed.

680 The chemistry of uranium. E. I. Rabinowitch and J. J. Katz. AECD-2624, nd. NNES, Div. VIII, Vol 11, Chaps. 1-10. Decl. June 7, 1949. 315p. For publication in NNES.

The report is divided into the following chapters: Nuclear Properties of Uranium; Properties of the Uranium Atom; Uranium in Nature; Extraction of Uranium from Ores and Preparation of Uranium Metal; Physical Properties of Uranium Metal; Chemical Properties of Uranium Metal; Intermetallic Compounds and Alloy Systems of Uranium; the Uranium-Hydrogen System; Uranium Borides, Carbides, and Silicides; Uranium Compounds with Elements of Group V.

681 The U. S. G. S. carbonate-phosphate-peroxide method for the determination of very small amounts of uranium in naturally occurring materials. M. D. Foster and R. E. Stevens. AECD-2630, nd. NNES, Div. VIII, Vol. 3 Decl. June 24, 1949. 14p. For publication in NNES.

A procedure is described for the determination of very small amounts of uranium (as low as 0.10 mg) in naturally occurring materials. Uranium is separated from the bulk of the constituents by repeated precipitation of them with sodium carbonate and is then coprecipitated with aluminum as phosphate in acetic acid solution. The phosphate precipitate is dissolved in sodium hydroxide-peroxide solution, and uranium is determined colorimetrically. A discussion of the important features of the method, experimental work done in connection with the development of the method, and comparative results by this and other methods are given.

CHEMISTRY (continued)

682 The U. S. G. S. cupferron-extraction method for the determination of very small amounts of uranium in naturally occurring materials. F. S. Grimaldi. AECD-2631, nd. NNES, Div VIII, Vol 3, Decl. June 24, 1949. 17p. For publication in NNES.

Detailed procedures are given for the determination of very small amounts of uranium (down to 0.002%) in naturally occurring materials of widely varying types. Uranium is concentrated by cupferron precipitation from reduced solution, then purified by cupferron precipitation and extraction of impurities after oxidation of uranium to the sexivalent state. Final determination is obtained colorimetrically in alkaline peroxide solution. Detailed procedures are presented, with experimental data in support of the principal steps of the procedures.

683 Assayer's guide. New Brunswick Laboratory. AECD-2640, nd. Decl. July 6, 1949. 82p.

Methods for the determination of the following are outlined: U_3O_8 in pitchblende, U_3O_8 in low grade ore and sands, U_3O_8 in ores high in arsenic and heavy metal, uranium in ores high in arsenic and heavy metals (modified procedure), U_3O_8 in carnotites and low grade pitch blendes (colorimetric), U_3O_8 in shales (colorimetric), U_3O_8 in phosphates (colorimetric), uranium in low grade ores and sands (fluorimetric), ThO_2 in ores (hexamine method), thorium oxide in ores (iodate method), and ThO_2 in monazite sand.

684 The U^{234} content of natural uranium and the specific alpha activities of the isotopes. C. A. Kienberger. AECU-310, Apr. 4, 1949. 10p. Proposed for publication in Phys. Rev.

The U^{234} content of natural uranium was determined, by a combination of alpha counting and mass spectrometer techniques, to be 0.005481 ± 0.000012 weight per cent, the precision being expressed on the basis of 95% probability. This corresponds to a half-life of $(2.522 \pm 0.008) \times 10^5$ years. Considering possibilities of bias, these figures are believed to lie within 1% of the true values. In conjunction with this determination, the half-lives of the other natural uranium isotopes were also measured.

685 Determination of naturally occurring radioactive elements. Clement J. Rodden. Analyt. Chem. 21, 327-35(1949) Mar.

Numerous chemical and radiochemical methods for the determination of uranium and thorium are reviewed. These include both direct and indirect methods utilizing the radiations (α, β and γ) and gravimetric, spectrophotometric and fluorometric methods. It is noted that the chemical determination of uranium in ores is the more accurate method. Thorium in minerals is most accurately determined by chemical means but may be estimated radiochemically. 82 references.

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686 Ultimate vacua of diffusion pumps. G. W. Sears. Rev. Sci. Instruments 20, 458-9(1949) June (Laboratory and shop notes).

An equation for the pumping-speed cut-off curve of a diffusion pump at low pressures is obtained and the discrepancy between the calculated effective pumping speed curve and the measured effective pumping speed curve is discussed. The effect of gases evolved by a diffusion pump, both from the decomposition of pumping fluid and from the outgassing of the pump and its contents during operation, are considered. It is noted that for a given amount of pumping fluid, the pump design having the greatest speed factor would give the lowest ultimate pressure and for a given pump, the lowest boiler temperature compatible with the maximum attainable pumping speed would give the lowest ultimate pressure. The results obtained are applied to the expanding nozzle pump recently described by Copley, et. al. (Rev. Sci. Instruments 6, 265(1935)); it is predicted that the limiting pressure of this pump should be lower, by a factor of 5, than the limiting pressure of the two-stage diffusion pump.

687 Application of nuclear radiation to industry. John R. Menke. Nucleonics 4, 2-6(1949) May.

Some of the actual and potential applications of nuclear particles and rays in industry are reviewed. The possible applications are treated in the light of the following classification of function: (1) identifying characteristics of a nuclear event (such as indication of source); (2) effects of nuclear radiations and particles on matter (such as ionization or displacement of atoms or molecules of the medium); (3) effects of matter on nuclear particles (such as penetration through, and scattering and absorption by, the medium); and, (4) reactions of nuclear particles with nuclei (such as transmutation of elements). In general, most industrial applications may be classified in the first three of the aforementioned groups, and most of the new tracer applications are included in (1). 23 references.

688 Industrial applications of radionuclides. John W. Irvine, Jr. Analyt. Chem. 21, 364-8(1949) Mar.

The industrial applications of radioisotopes as tracers and as radiation sources are reviewed. Following a brief outline of the theory of these two types of application, some of the specific applications, in fields such as industrial process development, product development, non-destructive measurement and testing, are discussed. Some of the hazards created by the applications of radioactivity in industry are also considered. 24 references.

689 Radioisotope gage. Don M. McCutcheon. Am. Foundryman 15, 35-9(1949) June.

A method for continuous indication of the liquid metal height in foundry cupolas has been developed. Use is made of the radioisotope Co^{60} to provide radiation having sufficient penetration to be detected by Geiger counter circuits after passing through the cupola above the liquid metal level. Variations in the design will permit the indication of a single level, multiple levels, or a continuous indication of the liquid level at all times during the melting and pouring cycle. Safety features have been included in the design of the gage to make it suitable for production departments. Patent rights to the system are held by the Ford Motor Company. 4 diagrams and 3 pictures.

690 Aspects of high-vacuum technique. G. W. Oetjen. Elecktrotech., Berlin 2, 333-40(1948) Dec. (in German).

Modern vacuum techniques are surveyed and the various types of gauges and leak detectors are described. Tables and graphs of the data available on rotary, ejection, and diffusion pumps, and on complete pumping units are included. The properties of working fluids and the problem of coordinating the pumping speeds of the fore-and fine-pumps are also treated.

691 A flexible vacuum seal. Otto Retzloff. Rev. Sci. Instruments 20, 324(1949) Apr. (Laboratory and shop notes).

A device is described which permits the rotation or displacement in any direction of an object in a vacuum chamber. It consists essentially of a sphere fitting in a spherical socket; a center rod slides

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along a diameter of the sphere and the junction is made vacuum-tight by an O-ring. With a vacuum of 10^{-4} mm or more inside the vacuum chamber, it is possible to rotate the sphere in any direction within 30 degrees of the central position as well as to push the center rod in and out and also to rotate it, without impairing the vacuum. A diagram of the apparatus is shown.

692 Lead-in seals for kinetic high vacuum systems using rubbers. Ralph C. Taylor and Carnot W. Ward. Rev. Sci. Instruments 20, 457(1949) June (Laboratory and shop notes).

It was found that metallic conductors embedded in a rubber matrix could be successfully used for vacuum seals in kinetic high vacuum systems in the pressure range of 10^{-5}–10^{-7} mm. Silicone and neoprene elastomers, when properly compounded with low vapor pressure materials, give good results but a butyl rubber GR-I was used because of its low permeability and good electrical properties. The following recipe was tried and found to function well and permit rapid evacuation of the system: butyl rubber GR-I, 100.00; zinc oxide, 5.00; stearic acid, 2.00; sulfur, 2.00; tuads, 1.00; M.B.T., 0.50; titanium dioxide, 40.00.—(vulcanized 35 in. at 300°F). A gasket construction found useful is shown which consists of a flat rubber ring. Best adhesion to the rubber was obtained if silver, copper, or nickel ribbons, or tubing plated with brass was used. The gaskets were vulcanized in molds with the metal inserts in place.

MINERALOGY, METALLURGY AND CERAMICS

693 Developments in high temperature ceramics on metals. Richard P. Horner. Steel Processing 35, 294-5,330(1949) June.

The author discusses ceramic coating developments that provide protection for mild steel and heat resistant alloys against oxidation, corrosion, and gas erosion. The constituent parts of a frequently used high temperature coating are presented. Several uses for the ceramic coatings are mentioned, i.e., short exhaust stacks for aircraft, marine and diesel mufflers, heat exchangers, etc.

694 Neutron well logging. Robert E. Fearon. Nucleonics 4, 30-42(1949) June.

The use of neutron well logging in the petroleum industry is described. By scanning the successively exposed strata of a boring in the earth with a detector and a source of neutrons, logging curves are obtained which are records of the intensity of secondary ionization as a function of the depth. The essential components of the apparatus thus used are shown and discussed. Following a formulation and application of the equilibrium equations to logging considerations, the sampling process is discussed and compared with coring. It is noted that owing to statistical fluctuations, lack of perfect duplication is a general property of neutron and γ-ray well logs. By the combined use of both types of logs, the driller can obtain much valuable information. 18 references.

695 Thorium in sea water and marine sediments. F. F. Koczy. Geol. Foren. I Stockholm Forh. 71, 238-42(1949) Mar.-Apr.

Experiments are described which show the precipitation of thorium in sea water. The adsorption of isotopes of radium and thorium on red clay, powdered manganous dioxide, and a powdered manganese nodule was determined. Radium adsorbed on all three powders, which is not the case with thorium. The thorium content of a few samples of marine sediments has been measured. They contain about 1×10^{-7} g Th/g. One manganese nodule investigated was found to hold as much as 1.3×10^{-6} g Th/g. The geochemistry of thorium and uranium in sea water is briefly discussed. An attempt is made to estimate the thorium content of sea water with the aid of the ratio Io: Th in the sediments. The thorium content of sea water is calculated to be 1 to 10×10^{-9} g Th/l.

696 Specific heat of sodium between 0° and 900°C, the melting point and heat of fusion. D. C. Ginnings, T. B. Douglas, and Anne F. Ball. AECD-2639, June 7, 1949. Decl. July 6, 1949. 22p.

Using an improved ice calorimeter and furnace, the enthalpy changes of two samples of pure sodium have been accurately measured by a drop method at a number of temperatures between 0° and 900°C.

MINERALOGY, METALLURGY AND CERAMICS (continued)

Equations are derived to fit the data, and values of enthalpy and entropy, based on zero values at 0°C, as well as the specific heat, are tabulated for both the solid and the liquid. Sources of significant experimental error are examined critically, and some theoretical implications of the results are discussed qualitatively. 16 references.

697 The surface tension of liquid metals and the excess binding energy of surface atoms. R. A. Oriani. AECU-319, May, 1949. 12p.

By assuming that the cohesive energy of a liquid metal can be expressed as the sum of the pairwise interaction energies of nearest neighbors, and by obtaining the number of effective nearest neighbors for atoms on the surface and in the interior from simple considerations, it is shown that the pairwise bonding energy of surface atoms is greater than that for atoms in the interior of liquid metals. With mercury as the sole exception, this excess bonding energy in a nearly constant 2% of the cohesive energy when the liquids are taken as close-packed, but the greater variation of this proportion is obtained when the liquids are taken as solid-like in structure.

698 The advantages of adding titanium to aluminum. H. Roehrig. (German). Mar., 1931. 10p. (NP-870).

A study is made of the effect of Ti-addition on the chemical and physical properties of Al. The adding of even very small quantities of Ti to pure Al or to Al-Si-Mg alloys has a marked grain-refining effect and counteracts the inherent tendency of aluminum to solidify in crystals, whose size increases rapidly with increasing degree of purity. The recrystallization grain of Ti-containing Al alloys is considerably finer than that of alloys free of Ti, hence the addition tends to increase mechanical strength and corrosion resistance of alloys subjected to work and heat-treatment. Ti improves the ductility of Al-alloys, provided correct heat-treatment temperature has been chosen. An optimum corrosion resistance of Al against organic acids and salt solutions is obtainable by additions of 0.11% to 0.18% Ti.

699 High temperature corrosion of metals. Andrew Dravnieks and Hugh J. McDonald. Corrosion 5, 227-33(1949) July.

The authors discuss the problems concerning the retention by metals of good mechanical properties at high temperatures and showing or posessing good resistance against chemical attack by gases. A number of general characteristics which play an important role in determining high temperature resistance of alloys include volatility of the reaction products, adherence of the scale to the metal, the relative thermal expansion and specific volume of metal scale, etc. The different "time-scale thickness" relationships result in different rates of metal corrosion. These may be classified according to whether they follow a linear, parabolic, logarithmic, or asymptotic growth law. In linear growth the scale grows at a constant rate; in parabolic growth the corrosion in 10 hr is about 3.2 times that in 1 hr; in logarithmic growth the decrease in rate with time is still more efficient; and in asymptotic growth the corrosion comes to a standstill when a very thin film of reaction product is formed on the surface of the metal. Although the logarithmic and asymptotic laws are the most desirable forms of scale growth from the standpoint of metal protection, most metals obey the parabolic growth law. Either gas or metal can diffuse through the scale and therefore the zone of scale growth may be either at the metal-scale or at the scale-gas interface. The most fruitful contribution has been the electrochemical theory of scale growth introduced by Wagner (Z. physik. Chem. B 21, 25(1933) and B32, 447(1936)). An elaboration of the electrochemical theory attempts to explain the mechanism of the diffusion of ions and electrons on the basis of the disorder theory of solids. Other theoretical developments which are considered include the effect of various factors such as pressure, rate of flow, presence of foreign substances in the gas phase, surface conditions of the metal, and variations in temperature, on the course of the reaction.

MINERALOGY, METALLURGY AND CERAMICS (continued)

700 Metallurgical considerations in the application of nuclear energy for the propulsion of aircraft. Walter J. Koshuba. Metal Progress, 635-40(1949) May.

The author discusses the problems involved in the application of nuclear power to aircraft propulsion. They are as follows: (1) the choice of the type of aircraft propulsion plant will influence the selection of materials; (2) the engineering and physico-chemical properties of materials above the range of temperatures in common use must be determined, studied, and correlated; (3) the selection of materials must satisfy the nuclear requirements for a given service application of the aircraft atomic plant; (4) the weight of the complete power plant must be sufficiently low to permit its use in a practical aircraft.

701 Micro analysis of gases evolved from metals. Gerald W. Keilholtz and Martha J. Bergin. Instruments 22, 320-1, 360-1(1949) Apr.

A micro-analysis unit has been used for the analysis of gases evolved from metals heated in a vacuum. The equipment used consisted of a static system containing r-f bombarder coils, sample, diffusion pump Toepler pump, McLeod gage, and cold traps, as well as an analytical system consisting of a diffusion pump for circulating the gases over the chemical reagents (which are arranged in a "ladder" formation for ready availability), and a Toepler pump which forces the gases into a small McLeod gage. Photographs and schematic diagrams of the apparatus are shown. The following data were obtained for a 30-min heating at 650°C (representing roughly the amount of gas evolved during the life of a vacuum tube):

Metal	gas volume
Aluminized steel	0.0029 cc
Carbonized nickel	0.0101
Plain steel	0.0698
Plain Ni-plated steel	0.0724
Oxidized-Ni-plated steel	0.0795
Blackened plain steel	0.0834
Plain nickel	0.0910
Carbonized Ni-plated steel	0.1510

It is noted that this method of gas analysis should be applicable to the determination of gas absorption and evolution (ranging from 0.01 to 2.0 cc) of all types of metals and gasses.

702 The preparation and some properties of ductile titanium. H. W. Worner. Metallurgia 40, 69-76(1949) June.

An account is given of the preparation of a ductile grade of titanium by a modification of the Kroll process in which no protective atmosphere of helium was needed. Australian raw materials were used. Each particle of titanium powder produced was porous, suggesting that the metal formed as a sponge-like mass during the reduction reaction. The chief metallic impurities were iron, magnesium, and lead, but the two latter impurities could be practically eliminated either by melting the titanium in an argon atmosphere or by heating to 1,000°C for several hours, the pressure being not greater than 10^{-4} mm.

703 Report on nickel-beryllium alloys. F. M. Walters. Naval Research Laboratory Report NRL-M-1633, July 8, 1940. 19p. (NP-871).

The tensile properties of six experimental nickel-beryllium alloys were determined for several heat treatments. The values found were equal to those appearing in the literature. Since nickel-beryllium alloys owe their strength to precipitation hardening, the limitations peculiar to such alloys are discussed.

MINERALOGY, METALLURGY AND CERAMICS (continued)

704 Tenth quarterly report to ONR on deformation of metals. University of Chicago Institute for the Study of Metals. May 17, 1949. 86p. (NP-798).

An attempt at interpreting observed staircase-like stress-strain curves in aluminum alloys has led to the concept of the initiation of new slip bands by previously formed slip bands, and has thereby led to the viewpoint that plastic deformation must, under a wide range of conditions, be regarded as a co-operative effort between grains, rather than that each grain deforms at a rate determined solely by the overall stress.

Stress-induced twinning may be regarded as taking place by a homogeneous shear strain. Such observations have led to the commonly accepted viewpoint that diffusionless phase transformations likewise take place by a homogeneous shear strain. This widely held viewpoint is questioned in the present report, and an alternative theory is presented based upon the concept of dislocations forming a spearhead for the advancing new phase. The essentially viscous-like behavior of grain boundaries has been demonstrated in a series of papers included in former reports. The present report contains a continuation of this series. It is shown that very small overall concentrations of certain impurity atoms block grain boundary slip. The relation between stress and strain is usually regarded as linear within the elastic range. However, highly localized strains, such as induced by foreign atoms may be so high as to give rise to considerable deviation from a linear relation between stress and strain. Some consequences of these deviations are discussed.

705 Various aspects of titanium metals. R. S. Stewart. Can. Mining J. 70, 59-66(1949) June.

A brief history of titanium is given and the present uses of the metal are discussed. The tetrachloride and iodide processes for producing the pure metal are presented along with its fabrication and properties. Several titanium base alloys are briefly mentioned. Proposed binary alloy diagrams for titanium-nitrogen and titanium-carbon are included. 32 references.

706 Prospecting for uranium ore using G-M counters. Samuel Freedman. Radio-Electronics 20 No. 10, 36-8(1949) July.

A few of the Geiger-Müller counters which are useful in prospecting for uranium ore, because of their simple construction, low cost, and satisfactory operating characteristics, are described. Circuit diagrams of four such counters are shown.

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707 Correlated probabilities in multiple scattering. W. T. Scott. AECU-272, nd. 22p. Proposed for publication in Phys. Rev.

The correlated probabilities of lateral and angular displacements of cloud chamber tracks, resulting from multiple small-angle scattering, have been calculated for several cases of interest. The results are applicable to curvatures and other measurements taken in the presence of a magnetic field. The usual Gaussian-type scattering law has been used in the form of the fundamental correlated distribution function derived by Fermi. One direct application of this function is to the effect of scattering on angle measurements in nuclear stars. A "three-point formula" is derived, involving a correlated distribution of two successive lateral displacements with the resultant angular displacement. The distribution of scattering produced curvatures, originally derived by Bethe, is calculated. A "four-point" formula allows a quantitative discussion of the tendency of scattered tracks to appear circular rather than skewed or S-shaped. Finally, a formula is derived for the distribution of the successive chord angles for a track observed at several points, and used to discuss the best method of averaging the observations to reduce scattering-produced curvature errors. The error produced by scattering is not appreciably diminished by taking the best mean for observation of the track at a large number of points, instead of a single observation of chord and sagitta (three points).

708 Multiple scattering of fast charged particles. H. S. Snyder and W. T. Scott. AECU-276, nd. 20p. Proposed for publication in Phys. Rev.

The theory of multiple scattering of charged particles has been extended in the small-angle approximation valid for thin foils and fast particles. The extension consists of an exact solution of the

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intergral diffusion equation for the correlated probabilities of lateral and angular displacements, and the numerical integration of the resulting expression for the angular distribution. The projection of the scattering on a plane has been used for simplicity. The results are expressed in terms of dimensionless variables η/η_0 and Z/λ representing respectively the deflection angle in terms of a small unit determined by the screening, and the foil thickness in terms of the mean free path for scattering. Numerical calculations for values of Z/λ from 100 to 84000, and for an adequate range of η/η_0, have been carried out, and tables have been made available. Curves are presented for a few values of Z/λ. The matching is shown between the approximately Gaussian result for small angles and the Rutherford single scattering result valid for large angles. The deviations of the new results from each of these limiting values is quite large over a wide range of angle. An explicit asymptotic formula for large is given, showing correction terms to the single scattering formula.

709 Production of very high energy photons by 350 Mev protons. Herbert F. York, Burton J. Moyer, and Russell Bjorklund. AECU-280, nd. 1p.

This document is in abstract form; it is reproduced below in its entirety.

A study is in progress, by means of a pair counter, of the yield of high energy photons from the target of the 184 in. cyclotron during 350-Mev proton bombardment. The energy distribution of the photons shows a broad maximum in the neighborhood of 70 Mev when the target is observed at an angle of 180 degrees (backward) with respect to the proton beam. Observations at an angle of zero degrees (forward) give a maximum above 100 Mev. The cross section per Be nucleus for producing photons between 30 and 105 Mev is of the order of 10^{-27} cm^2. With 175-Mev protons the spectrum shows no maximum and the yield is about 100 times smaller. Theoretical considerations of bremsstrahlung predict only a small increase in yield in going from 175 to 350 Mev, and do not predict a maximum. In establishing the photon nature of radiation we have checked the recent attenuation measurements of Lawson. Observations will be made for various targets at various angles, and, on the possibility that these gammas are associated with neutral meson decay, search will be made for gamma-gamma coincidences.

710 The properties of atomic nuclei. II. Range-energy curves for alpha particles, protons, and mesons. Hans A. Bethe. AECU-347, June 1, 1949. 25p.

Energy-range curves are given for alpha particles in air; for protons in air, hydrogen, glycerol tristearate, aluminum, copper, silver, and lead; for μ-mesons in air, water, iron, and lead.

711 Continuous x-ray spectrum from 8A to 14A. S. T. Stephenson and F. D. Mason. Phys. Rev. 75, 1711-16(1949) June 1.

The continuous x-ray spectrum has been studied at voltages from 1.1 kv to 2 kv and at wavelengths from 8A to 14A using a vacuum single-crystal Geiger counter spectrometer. The measurements were corrected for window absorption and counter efficiency but were not corrected for absorption in the target or for the reflecting power of the crystal. The total intensity in the continuous spectrum, as measured and partially corrected, is found to be proportional to the atomic number of the target, a result similar to results obtained for shorter wavelengths, but the total intensity is not proportional to the square of the voltage applied to the tube. The shapes of the curves approach the shape to be expected from a thin target. 17 references.

712 Determination of the energy distribution of bremsstrahlung from 19.5 Mev electrons. H. W. Koch and R. E. Carter. Phys. Rev. 75, 1950-1(1949) June 15 (Letter to the editor).

The bremsstrahlung spectrum has been measured for 19.5-Mev electrons produced by a betatron and directed against a 0.005-in. thick platinum target. The relative intensity of the x-rays as a function of energy was determined from the energy distribution of the pair electrons produced in a cloud chamber. Data were obtained on approximately 1300 pair-electrons produced in the field of a nucleus and 33 pair-electrons produced in the field of an electron. From 40,000 stereoscopic photographs, 10,300 have been analyzed. The method by which it was possible to completely specify the

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electron and positron helices in space is described. This was necessary in order to determine the sensitivity of the experimental apparatus to detect or to discriminate against certain energy ranges of pairs. The x-ray intensity spectrum as deduced from the corrected pair spectrum obtained with a total of 1130 pairs is compared with the theoretical spectrum as calculated by Schiff using the Bethe-Heitler theory (private communication). It is noted that the difference in shape indicates relatively more experimental quanta in the middle energy ranges. Results have also been obtained on the positron fractional energy, the particle-quantum angles, and pairs produced in the field of an electron. The data provide a consistent picture of pair and triplet production and serve to test the reliability of the weighing factor principles used for correcting the x-ray spectral distribution.

713 Inelastic scattering of low speed electrons from a copper single crystal. Paul P. Reichertz and H. E. Farnsworth. Phys. Rev. 75, 1902-8(1949) June 15.

The energy distribution of inelastically scattered electrons from a (100) face of a copper single crystal has been investigated by the electrostatic deflection method. Using normal incidence of the primary electrons, observations were made in the neighborhood of two strong diffraction peaks in the (100) azimuth, one at 59.9-ev primary energy and colatitude angle 60 degrees, and one at 114.5 ev and 40.5 degrees. Discrete loss peaks were observed at about 3.0-, 6.0-, 12.3-, and 20.0-ev energy loss with the intensities depending on both primary energy and colatitude angle. An excess of inelastic scattering occurs near the elastically scattered diffraction beams so that maxima are observed in the curves giving the intensity of inelastic scattering as a function of primary energy for constant values of energy loss. Near the 59.5-ev diffraction beam the maxima of the curves for different values of energy loss occur at a constant value of primary energy. This suggests that the inelastic scattering takes place after diffraction, but the fact that the maxima occur at 56 ev instead of 59.5 ev is not understood. For inelastic scattering near the 114.5-ev diffraction beam the results are complex but are approximately explained by assuming (1) inelastic background scattering followed by diffraction, for energy losses below 10 ev; and (2) the same as (1) plus diffraction followed by inelastic background scattering, for energy losses above 10 ev. Possible reasons are given for the fact that the maxima for the latter process occur 3.5 ev above the energy for the diffraction maximum.

714 Inelastic scattering of protons by magnesium and aluminium. E. H. Rhoderick. Nature 163, 848-9(1949) May 28.

The inelastic scattering of protons by some light elements has been investigated experimentally using 4.5 Mev protons; the energy spectrum of the scattered protons was determined by using a proportional counter in conjunction with absorbing foils in an experimental arrangement similar to that used by Dicke and Marshall (Phys. Rev. 63, 86(1943)). Only proton groups corresponding to the excited states less than 2.5 Mev above the ground-state were able to reach the counter. The spectra of protons scattered by magnesium and aluminium are shown and discussed. By an indirect method (accurate only to within 30%) it was estimated that the total cross-section for excitation of magnesium to the 1.38-Mev state by 4.73-Mev protons is about 8×10^{-25} cm^2, while that for excitation of aluminium to the 0.97-Mev state by 4.4-Mev protons is about 1.2×10^{-25} cm^2. A few observations were also made using beryllium.

715 A new method of measuring the stopping power of several materials for alpha-particles. F. Emmett Hammer and Frank E. Hoecker. Rev. Sci. Instruments 20, 394-8(1949) June.

The application of an atmospheric pressure α-particle detector to the measurement of the relative stopping power of thin films of absorbing material for α-particles was investigated. The air-equivalent of absorbing films was measured directly by balancing the counting rates of two detectors in air, and again when an absorbing film is inserted between one of the detectors and its source. Measurements of the air-equivalent and relative stopping powers of films of mica, polystyrene, and aluminum are given. The relative stopping powers determined agree well with previous values. The errors of the method are discussed and an attempt is made to specify the magnitude of the probable error in the result.

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716 The scattering of deuterons by helium at deuteron energies from 0.9 to 3.5 Mev. J. Morris Blair, George Freier, E. E. Lampi, and William Sleator, Jr. Phys. Rev. 75, 1678-80(1949) June 1.

The differential cross sections for the elastic scattering of deuterons by helium have been measured for deuterons of 0.9 to 3.5 Mev over an angular range from 15 to 160 degrees in the center-of-mass system. The probable error in the absolute values of the cross sections is 3% or less. For angles greater that 60 degrees the cross sections are roughly independent of angle except at 3.5 Mev where they decrease with increasing angle up to 90 degrees and increase beyond.

717 A cloud chamber of light weight for balloon flights. R. P. Shutt, A. L. Johnson, and A. M. Thorndike. AECU-274, nd. 11p.

A light weight cloud chamber has been constructed. A plastic material was used for the transparent walls of the cloud chamber. Most of the other parts consisted of tin-plated aluminum. The plastic front wall of the cloud chamber and the walls limiting the motion of the rubber diaphragm bringing about the expansions were somewhat curved and therefore could be made thin. The remaining parts were also kept thin by distributing material stresses, making use of a relatively large number of bicycle spokes for holding the chamber together, rather than the usual smaller number of heavy bolts. In order to adjust the expansion ratio a mechanism which is removed before a flight was attached to the cloud chamber. Besides saving weight, the latter feature also reduced the amount of compressed air to be carried along for operating the cloud chamber. The resulting cloud chamber was 12 in. in diameter, $3\frac{1}{2}$ in. deep, and weighed 6.3 lb. It is thought that by making use of magnesium where possible, and admitting higher material stresses, one might save another one or two pounds in a similar design. The fabrication of the individual parts of cloud chamber are discussed in detail. Photographs and a schematic diagram are included.

718 Some cloud chamber photographs obtained with a high pressure cloud chamber. R. P. Shutt, G. R. Hoke, W. A. Tuttle, and G. F. O'Neill. AECU-275, nd. 1p.

This document is in abstract form; it is reproduced below in its entirety.

In a high pressure cloud chamber described previously, approximately 1,000 stereoscopic pictures have been obtained at sea level. A few events that may be of interest are to be discussed. The cloud chamber was filled with argon at a pressure of 140 atm, and a magnetic field of 4,000 gauss was applied. Several negatively charged mesons appeared to stop in the gas of the cloud chamber without another particle appearing, while a few positive mesons seemed to decay into electrons in accordance with now well-accepted experimental results of others. Furthermore, pictures of two small stars originating in the gas and containing two and three prongs, respectively, were obtained. The prongs show an average range of 1 cm in the gas at high pressure. Finally, a star containing seven prongs originating at a point in the gas was photographed. The shortest of these tracks can be seen to end inside the cloud chamber. From the small amount of scattering and the large density of ionization, it can be identified as a proton with fair certainty. Its initial energy would amount to about 70 Mev. There is another proton of comparable energy. The remaining five tracks are also straight and only lightly ionized. One can estimate that the total energy involved in the star is at least of the order of 10^9 ev. In none of these cases is a particle visible that could have produced a star. We, therefore, assume that a fast neutron was responsible for these nuclear collisions.

719 Production of mesons by x-rays. Edwin M. McMillan and Jack M. Peterson. AECU-315, nd 1p.

This document is in abstract form; it is reproduced below in its entirety.

The first experimental program to be undertaken with the Berkeley synchrotron is a study of meson production. The emergent beam of 335-Mev x-rays passes through a stack of nuclear plates (Ilford F-3), or through a slab of matter in the vicinity of such plates; then meson tracks in the emulsion are sought by microscopic examination. The results prove conclusively that mesons are produced, and that they are not the result of secondary heavy particles and most probably not the result

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of secondary electrons. A very rough estimate of the cross section for meson production by x-rays in glass is 3×10^{-30} cm^2 per nucleon. The number of quanta is here defined as the total x-ray energy divided by the peak quantum energy. Since only mesons with energies below about 10 Mev will stop in the stack of plates and be counted, the actual cross section may be considered larger. Out of a total of 145 tracks recorded, 91 end in stars. Assuming that three quarters of all negative π-mesons produce stars, and that every positive π-meson is accompanied by a μ, this leads to a ratio negative π/positive $\pi \sim 10$. The actual π-μ decay is not always discernable on these rather insensitive plates; only 5 cases have been seen. The statistics given above include mesons from both glass and carbon, and in both cases the excess of negatives is apparent.

720 Improved mass values for π^-, π^+, and μ^+ mesons. A. S. Bishop, H. Bradner, and F. M. Smith. AECU-324, nd. 1p.

This document is in abstract form; it is reproduced below in its entirety.

The two major sources of error in the previously reported values (A. S. Bishop, Bull. Am. Phys. Soc. 24, No. 2, 17 (1949)) of π^-, π^+, and μ^+ mesons are (a) the uncertainty in the absolute value of the magnetic field of the 184-inch cyclotron, and (b) the error in the range-energy relationship for mesons in Ilford C-2 emulsions. Two independent methods of minimizing these errors are being pursued. The most obvious method involved a redetermination of the magnetic field strength by the method of nuclear induction, together with a direct measurement of the range-energy relationship in Ilford C-2 emulsion of protons from 13 to 40 Mev (corresponding to meson energies from 2 to 7 Mev). The second procedure is that of comparing the mass of the meson to that of the proton, when the apparent mass of the latter is also determined by $H\rho$ and range. In this way, approximate cancellation of the above errors can be achieved merely by selecting for measurement those protons with the same velocity as the mesons being measured. Results from both methods of measurement will be reported.

721 High energy events at high altitude. J. Hornbostel and E. O. Salant. AECU-333, nd. 1p.

This document is in abstract form; it is reproduced below in its entirety.

At 93,000 feet, star production in nuclear emulsions at 31 degrees geomagnetic latitude (cut-off 8 Bev) is about 0.3 production at 57 degrees. Cross sections for disintegration by Bev primaries are estimated. On minimum ionization plates (Eastman NTB3), 10% of stars show, in addition to customary heavy, unoriented tracks, a narrow broom-like bundle of relativistic particle tracks, fanning out downwards. In 90% of such broom events, the star has a single minimum ionization track in the hemisphere above it; this track is consistent in energy and location with being due to the incident particle. The broom consists usually of 2 to 4 tracks, collimated within ± 10 degrees about the incident direction, but about a tenth of the brooms have 6 to 20 tracks, collimated within ± 30 degrees of incident direction, and including some less energetic particles, about 4 times minimum ionization. Reasons for regarding the collimated stars as creation of fast mesons by primaries of energy greater than cut-off, and estimates of cross section for such events, are presented.

722 Absorption of particles of extensive atmospheric showers of cosmic radiation. Pierre Auger, Jean Daudin, Andre Fréon, and Roland Maze. Compt. rend. 228, 178-80(1949) Jan. 10 (in French).

The theory offers two indirect methods for the measurement of absorption coefficients of extensive showers: (1) one small counter under lead is in coincidence with two groups of large free counters; the number recorded is proportional to the "apparent" surface of the small counter, this surface being that of a free counter equivalent to one under lead (Daudin, Annales de Phys. 20, 563 (1945)); the result is the true absorption coefficient; (2) several equal counters under lead are in coincidence; the absorption coefficient found is γ times greater than that determined by the first method; γ belongs to the formula $N = N_0(h)d^{-\gamma}$ giving the variation of the number of showers N with their density d; here $N_0(h)$ and γ depend on the altitude; at sea level $\gamma = 1.5$. The authors' experiments at various altitudes, with lead filters 2 to 12 cm thick, confirmed these views. The absorption coefficient found, 0.024 ± 0.002 cm^2/g is intermediate between those of electrons (0.042) and μ-mesons (0.001). This result, inadmissible in the current cascade theory, points to the existence of new particles, such as the λ-mesons of Auger et. al. (Compt. rend 226, 169 and 569(1948)) and Daudin (Compt. rend. 226, 484(1948)).

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723 Cloud chamber equipment for study of infrequent cosmic-ray processes. W. Y. Chang and J. R. Winckler. Rev. Sci. Instruments 20, 276-85(1949) Apr.

A cloud chamber is described which operates if a particle passes through a vertical telescope and stops before reaching anticoincidence counters under the chamber. The chamber is surrounded by a minimum amount of material, and a large number of the anticoincidence events consist of particles stopping in foils of aluminum, iron, and lead within the chamber. The expansion valve is of the fast electromagnetic type having a thin iron diaphragm which completes a magnetic circuit when closed. Six slow expansions for clearing the chamber occur immediately after each event. The chamber is housed in an insulated room kept within ±0.1°C. The Geiger counter coincidence circuits operate time delays for controlling the expansions, flash lamps, camera, clearing field, and recorders. The electronic circuit used is suitable for the study of very infrequent events. Several pictures of meson decay and shower events are presented. 15 figures.

724 Cosmic ray physics. D. J. X. Montgomery. Princeton University Press, Princeton, N. J., 1949. 370p.

This book is an up-to-date survey of the experimental data which have been taken and the theories which have been advanced in cosmic ray work up to 1948. The major emphasis has been placed on the principles underlying cosmic ray experiments and the interpretation of experimental results. Although the theoretical methods are broadly sketched in a qualitative fashion, most of the detailed calculations have been omitted. Exhaustive lists of references are included.

725 On the cosmic-ray stars. Y. Fujimoto and Y. Yamaguchi. Phys. Rev. 75, 1776-7(1949) June 1 (Letter to the editor).

Some recent results and theories concerning the origin of cosmic-ray stars are discussed and interpreted. It is concluded that proton-decay would be expected to predominate over other evaporation processes and it is noted that this hypothesis will also explain the appearance of low energy protons in stars. A detailed account of this work will be published soon in Progress of Theoretical Physics.

726 A counter controllable high pressure cloud chamber. G. E. Valley and J. A. Vitale. Rev. Sci. Instruments 20, 411-23(1949) June.

A high pressure cloud chamber is described which is designed for ease of counter control as an ordinary cloud chamber. The instrument is fitted with a magnet capable of producing a field of approximately 10,000 gauss continuously. It is mounted in a trailer and can be readily transported to mountain sites.

727 A critique of ionization measurements of nuclear disruptions produced by cosmic radiation. Serge A. Korff. Revs. Modern Phys. 21, 75-81(1949) Jan.

The principal features of ionization measurements made with proportional counters are reviewed and some of the limitations of this method of counting are discussed. The instruments of this type which are available are described. Detection of slow neutrons (by capture), of fast neutrons (by recoil), and of protons are considered. It is noted that various backgrounds and contaminations will result in simultaneous counting of several of these particle-types and some of the methods of separating and evaluating different such events are treated. These include varying the shielding, counter size, pressure and nature of the filling gas, and other parameters.

728 Differential counting with reversible decade counting circuits. Frederick H. Martens. Rev. Sci. Instruments 20, 424-5(1949) June.

Three circuits were designed and built to apply a reversible decade counting circuit to the direct measurement of the difference in the counting rate from two counter tube telescopes used in cosmic-ray research. The circuits are equally applicable to the direct measurement of the difference in the strength of two radioactive samples. An input circuit prevents two pulses from the Geiger tubes from arriving simultaneously at the first ring-of-ten. A driving circuit switches and shapes the pulses for

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correct bi-directional operation of the ring-of-ten. A coupling circuit permits two decade rings to be operated in cascade, giving a differential electronic scale of 100.

729 Energy spectrum of secondary electrons from μ-meson decay. Louis Michel. Nature 163, 959-60(1949) June 18.

The energy spectrum of the electron emitted in the disintegration of the μ-meson at rest has been calculated on the following assumptions: (1) the μ-meson has spin 1/2; (2) it decays spontaneously according to the scheme $\mu^{\pm} \rightarrow \epsilon^{\pm} + \lambda + \nu$, where ϵ indicates an electron, ν a neutrino and λ a neutral particle of spin 1/2 with a mass either nonvanishing or more probably zero, in which case it can be identified with a neutrino. The process is treated by ordinary perturbation theory; each charged particle is described by a plane wave according to Dirac's hole theory. For the neutral particles two theories are used: (a) Dirac's hole theory, assuming that it is possible to distinguish the particles from the anti-particles and (b) Majorana's abbreviated theory (Nuovo cimento 14, 171(1937)), which identifies the particles and the anti-particles. The Hamiltonian of interaction is the same as for the β-decay theory, with five interaction constants. All possible ways of constructing a Hamiltonian of this kind are shown to be equivalent by suitable linear transformations of the five interaction constants. The probability of observing an electron in a particular energy range is considered and the two cases which result if $\lambda = 0$ are discussed.

730 Extensive penetrating showers. John Ise, Jr. and W. B. Fretter. University of California, nd. 30p. (NP-938).

Descriptions and results of experiments carried out during the summer of 1948 at Tioga Pass (elevation 3026 meters) in Yosemite National Park on the density spectrum of the penetrating particles in Auger showers are reported.

731 Intensity of cosmic-ray stars and slow mesons in the stratosphere. J. J. Lord and Marcel Schein. Phys. Rev. 75, 1956-7(1949) June 15 (Letter to the editor).

Data on the variation of the events, occurring in photographic emulsions (Ilford C2, boron-loaded plates, 100 microns thick), with altitude has been obtained using free balloons in the stratosphere. The variation of the number of events with altitude is given for stars having more than four tracks and for mesons stopping in the emulsion with a range greater than 100 microns. (The data are given in terms of pressure instead of altitude.) Assuming that the variation of star intensity with altitude is an exponential function of the atmospheric pressure, the curve obtained corresponds to an absorption coefficient of 148 g/cm^2 for the star-producing radiation.

732 Mechanism of π-meson disintegrations. D. H. Perkins. Phil. Mag. 40, 601-13(1949) June.

Observations on the disintegration stars produced by the nuclear capture of negative slow mesons in plates exposed to cosmic radiation are described. The results are in agreement with the hypotheses previously advanced by Heidmann and LePrince-Ringuet (Compt. rend. 226, 1716(1949) Jan.) and Perkins (Nature 161, 487(1948); 160, 299(1947)) to account for the conversion of the meson rest energy into nuclear excitation energy, i. e., that this mass energy is transferred into kinetic energy of one or two nucleons which subsequently excite the nucleus during their passage through it. Previous measurements of the star-producing mesons and evidence from the grain counts which are described in detail indicate that the stars can almost all be identified with the negative π-mesons of mass $285m_e$ which have been produced in the Berkeley cyclotron. Separation of the stars into those from heavy and light nuclei indicated that none of the stars are produced by negative μ-mesons. It is noted also that the energy dissipated in the meson-produced disintegrations is much less than the rest-energy of the meson ($m\pi \sim 140$ Mev.). Examination of the energy distribution of protons from meson stars indicates that one or two fast neutrons, of energies at least 60 Mev, are probably produced in a primary process by annihilation of the meson. These lose only a fraction of their energies in traversing the nucleus and producing excitation followed by evaporation. The average energy loss is approximately what would be

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expected for neutrons of energy ~70 Mev, suggesting that the meson interacts with a neutron-proton pair, giving two fast neutrons moving off in opposite directions. Most of the multi-prong stars due to π-mesons arise from light nuclei. In about half the disintegrations following capture of a π-meson by a heavy nucleus, a single proton or α-particle is emitted, and most of the remainder lead to ejection of neutrons only. Thus about one quarter of all the π-mesons do not produce a visible star on coming to rest in the emulsion. Since neutrons with energies ~70 Mev. are above the fission threshold in lead, bismuth, etc., meson-induced fission should be a probable process in such nuclei. Examination of plates in which layers of lead phosphate are sandwiched between layers of normal emulsion, is in progress. Such processes will be difficult to observe owing to the small amount of lead which can be incorporated by this method.

733 Momentum spectrum of the particles in extensive air showers. S. M. Mitra and W. G. V. Rosser. Proc. Phys. Soc. (London) 62A, 364-8(1949) June 1.

An account is given of experiments on the momentum spectrum of the particles in extensive air showers at sea-level. The results are consistent with an integral spectrum of the form $N(>E) \propto (E + E_c)^{-(1.1 \pm 0.3)}$, where E_c is the critical energy in air. Penetrating particles are found in some of the denser showers, the ratio of penetrating particles to electrons being $(0.8 \pm 0.4)\%$.

734 The nature of penetrating particles in air showers. L. Jánossy and C. B. A. McCusker. Nature 163, 181-3(1949) Jan. 29.

The nature of the penetrating particles which occur in air showers is considered in the light of previous experiments by Chowdhuri (Nature 161, 680(1948)) which are compared with these done by other experimenters. From the data it is concluded that the penetrating particles must be either of the two following types: (1) particles somewhat heavier than electrons, created by photons by pair production; or (2) neutral particles emitted by electrons as a kind of collision radiation. The former is considered the most likely of the two possibilities. It is noted that the results of the numerous investigations discussed indicate that at least an appreciable fraction of the penetrating particles in air showers differ in nature from previously observed particles and it is suggested that these new particles are heavy electrons. Calculations are made which indicate that such a hypothesis is not unreasonable.

735 Nuclear collisions of heavy cosmic-ray primaries. H. L. Bradt and B. Peters. Phys. Rev. 75, 1779-80(1949) June 1 (Letter to the editor).

Eight narrow showers of relativistic particles have been observed in a 3 in. × 10 in. stack of 25 electron-sensitive Eastman NTB3 plates at an altitude of 92,000 ft. In the three cases where the incoming nucleus belonged to the carbon, oxygen, nitrogen group the shower contained only protons or a mixture of α-particles and protons. In the remaining five cases where the bombarding nuclei have charges Z = 14, 19, 20, 26, and 26 the shower contained in each case one heavy fragment of charge Z = 10, 11. 10, 10, and 20, respectively. This type of shower is the result of a nuclear collision in which part of the nucleus is sheared off and the remaining nuclear matter proceeds with its original momentum either as a compact nucleus of reduced charge or as one which is partially or completely dissociated. The frequency of these showers is comparable to the number of collisions leading to total destruction of the incoming particle. They have not been observed earlier because all the lighter shower particles being in the relativistic range will only be recorded in electron-sensitive emulsions, such as the Eastman NTB3 plates. From measurements of the angles between the shower particles the energies of the particles have been estimated. In the case of one of the collisions shown, the energy of the incoming particle is estimated as 5 Bev/nucleon.

736 The mass of cosmic-ray mesotrons. J. Gordon Retallack and Robert B. Brode. Phys. Rev. 75, 1716-21(1949) June 1.

Mass determinations of 43 cosmic-ray particles have been made. The calculations were based on cloud chamber observations of the curvature of mesotrons in a magnetic field of 4750 gauss and the

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subsequent range of the particles in a second cloud chamber containing 15 plates of 0.67-cm thickness. Data consistent with a mass of 215 ± 4 m_e were obtained for 37 of the particles. Of the 6 remaining observations, 4 indicate masses much too large (474, 538, 588 and 717) to be reasonably considered as statistical fluctuations in the observations of normal mesotrons. The remaining 2 observations (114 and 120) also appear to be inconsistent with the normal mass of the mesotron and the observed probable errors in individual measurements in this experiment.

737 Observations of cosmic rays at high altitudes. Raymond V. Adams, Carl D. Anderson, and Eugene W. Cowan. Revs. Modern Phys. 21, 72-75(1949) Jan.

An estimate of the relative number of electrons occurring singly at 30,000 feet was made by means of a study of 272 photographs taken when the experimental arrangement was identical with that previously used for determining the momentum distribution, except for the presence of a 0.35-cm lead plate placed horizontally across the center of the cloud chamber. These data were of interest since it had been previously suggested that the low momentum end of the spectrum would be expected to contain electrons. Thus, for sea level data, the selection of single tracks for momentum measurements effectively removes the electron component and the single-particle spectrum represents the mesotron component, principally. On the other hand, at high altitudes, the single track criterion might be expected to result in the inclusion of a considerable number of electrons, i.e., because of the rapid increase with altitude of the electron shower component relative to the single particles, there should result a much greater probability for the appearance of single electrons at high altitudes. Data taken on the momentum distribution of mesotrons at 30,000 ft indicate that this criterion is valid for momenta above approximately 250 Mev/c. Using the new data, the previous momentum data have been corrected for electrons at low energies. It is noted that at 30,000 ft the maximum of the momentum distribution curve occurs at about 300 Mev/c as compared with about 700 Mev/c for the sea level data. In addition data are given on the angular distribution of large air showers at 31,000 ft which were taken from 228 photographs obtained using a cloud chamber having an internal diameter of 87 cm and a 15-cm depth. The histogram obtained does not show as broad a distribution as that predicted by the theory (M. M. Mills, Bull. Am. Phys. Soc. 23, 4(1948)). This discrepancy is difficult to account for on the basis of the type of selection used and the experimental errors which affected the results.

738 On the absorption of meson-producing nucleons. W. Heitler and L. Jánossy. Proc. Phys. Soc. (London) 62A, 374-85(1949) June 1.

The absorption of nucleons passing through any number of nuclei is calculated with due consideration of all fluctuations of energy loss. For the probability $w(\epsilon,E)d\epsilon$ for an energy loss ϵ by a nucleon with energy E hitting a nucleon at rest, a law of the form $wd\epsilon = w(\epsilon/E)d\epsilon/E$ is assumed, a law suggested by meson theory and bremsstrahlung. It is shown that, with a primary spectrum, following a power law, the absorption is strictly exponential for any thickness of the absorber and for all energies of the nucleons, apart from small deviations at low energies due to the latitude cut-off. This agrees well with recent experimental results. The experiments also permit some conclusions about the shape of the function w, and it is shown that w must be a fairly broad distribution extending up to $\epsilon/E = 1$, possibly favoring, but not to a very large extent, low values of ϵ/E. The average energy loss of a fast nucleon hitting a nucleon at rest is determined by the experiments within very narrow limits. The conclusions that can be drawn about w, the total cross-section for meson production and the average energy loss are all compatible with the theory of Hamilton, Heitler and Peng (Phys. Rev 64, 78(1943)), in its later version.

739 On the origin of cosmic rays. R. D. Richtmyer and Edward Teller. Phys. Rev. 75, 1729-31(1949) June 1 (See also Nuclear Science Abstract 2-1564).

The presence of heavy particles in cosmic rays suggests the possibility that cosmic radiation is generated by the acceleration of charged particles in extended electromagnetic fields. The energy density of cosmic rays (3×10^{-10} Mc^2/cm^3) would lead to very great total amounts of energy if one assumes that cosmic radiation extends throughout intergalactic or throughout interstellar space. This

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would require very efficient methods of cosmic-ray production. It is, therefore, of interest to investigate the possibility that cosmic rays are generated in the vicinity of the sun and are confined to the solar system by extended magnetic fields. The strength of these fields is estimated to be 10^{-5} gauss. According to this picture, cosmic rays circulate in the neighborhood of the planetary system for thousands of years, during which time the radiation becomes isotropic. The electron component of the radiation is eliminated by collisions with solar light quanta.

740 On the production of cosmic-ray stars in the stratosphere. J. J. Lord and Marcel Schein. Phys. Rev. 75, 1956(1949) June 15 (Letter to the editor).

The effect of absorbing material (lead plates) covering photographic plates on the number of events produced in the emulsions by stratosphere cosmic rays has been measured through the use of free balloons. Curves of the rates of occurrence of various events as functions of the absorber thickness are shown. From the results obtained it is concluded that at altitudes close to the top of the atmosphere, the stars of less than four prongs must be produced by secondaries generated in the material placed around the photographic emulsion. Preliminary results obtained using carbon and paraffin indicate that this effect is strongly dependent upon atomic number and is considerably smaller in light materials than in Pb.

741 On the solar origin of cosmic radiation. Hannes Alfvén. Phys. Rev. 75, 1733-5(1949) June 1 (See also Nuclear Science Abstract 2-1564).

The previously suggested possibility (R. D. Richtmyer and E. Teller. Phys. Rev. 75, 1729(1949)) that cosmic radiation is a local solar phenomenon, is developed. It is shown that motion of interstellar matter is likely to amplify a primary interstellar magnetic field up to the value of the order 10^{-5} gauss postulated by Richtmyer and Teller. According to an earlier suggestion (H. Alfvén. Nature 158, 618(1946)), magnetic storm variations of cosmic radiation are due to electric fields set up within the solar system by the storm-producing beams. It is shown that the long-time effect of the same mechanism may account for the generation of cosmic radiation. The author notes that it may be possible to theoretically derive the observable energy spectrum.

742 Photograph of a shower produced by a π-meson and a π-μ-decay. M. S. Sinha. Phys. Rev. 75, 1757-8(1949) June 1.

A photograph is shown of a shower which was apparently produced by the interaction of a π-meson with a nucleus in a cloud chamber. The photograph is of interest since, although the production of multiple heavy particles by such an interaction has been established by investigations with photographic plates, there has been little evidence obtained using cloud chambers. The energy of the incident particle at the time the shower was produced has been estimated as 2.04×10^{-9} ev. It is also estimated that the average total energy of each of the particles emitted is about 3.1×10^{8} ev. It is noted that the possibility that the aforementioned are π-mesons cannot be excluded since the energy available is above the rest mass of the π-meson.

743 Polarization effects of vector-mesons. Gregor Wentzel. Phys. Rev. 75, 1810-14(1949) June 15.

Adopting a vector-meson model for the π-meson, the following were studied: (1) the polarization of π-mesons produced in nucleon-nucleon-collisions; (2) the angular distribution of μ-mesons resulting from π-μ-disintegrations, as a function of the polarization of the π-mesons; (3) the effect of electromagnetic fields on this polarization, in particular; and (4) the depolarization caused by the electric fields in matter. It is concluded that the theoretical results are encouraging for an experimental investigation.

744 The production of cosmic ray stars. George Thomson. Phil. Mag. 40, 589-600(1949) June.

Present experimental knowledge of the production of stars and single tracks in photographic plates by cosmic rays is summarized and some calculations relating to the energy spectrum are made. In

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particular the observed exponential variation of the effects and the constancy of the size of the star with varying height are considered and shown to be consistent with the view that one primary particle makes several effective collisions in the atmosphere. Although no unambiguous decision as to the mechanism of the production can be made, it is noted that some possibilities can be excluded. It is most likely that the effects are due either to nucleons passing down through the atmosphere and alternating in state between protons and neutrons as a result of nuclear collisions, or to neutrons. In either case each "primary" particle must make several tracks or stars. The production of tracks by the primaries is direct; that of the stars may be direct or through a non-ionizing link, such as some kind of a neutral meson. 18 references.

745 The properties of cosmic radiation in the lower atmosphere. Martin A. Pomerantz. Phys. Rev. 75, 1721-8(1949) June 1.

Experiments performed previously (Phys. Rev. 75, 69(1949)) with apparatus carried to very high altitudes by free balloons have been conducted in the lower portion of the atmosphere. Two different instruments were operated in a B-29 airplane, and at Mt. Evans, Colorado. Absorption curves in Pb, up to a thickness of 18 cm, were obtained at 14,260 ft, 25,000 ft, and 30,000 ft. Intensity vs altitude curves for the lower regions of the atmosphere may now be combined with those for very high altitudes without an arbitrary normalization. A direct comparison has been made between the present measurements and others which have been made on the relative change of intensity between sea level and Mt. Evans, and the absorption in Pb at Mt. Evans. Factors for the conversion of all of the data to absolute intensities have been determined utilizing a γ-ray howitzer method for measuring the effective length of a G-M counter. Satisfactory agreement with the values of the absolute intensity previously measured by others at sea level and at Mt. Evans was obtained. The absolute intensity of cosmic-ray particles near the "top of the atmosphere" at geomagnetic latitude 52°N is given as 10.1 ± 0.20 particles/min/cm^2/unit solid angle. Consideration is given to the appreciable error which may be introduced in the comparison of measurements of the "total" intensity at very high altitudes obtained with different G-M counters. 16 references.

746 A recording meter for auroral radiations. W. D. Penn and B. W. Currie. Can. J. Research 27A, 45-52(1949) May.

The authors describe a device that was developed to give a continuous record of the intensity of auroral radiations from the zenithal sky. Detection is by means of the multiplier phototube, RCA type 1P21. A null method of recording is used, the light flux reaching the phototube being kept to a constant value by moving a neutral, wedge filter in front of the phototube. A simple servo-mechanism is used for this purpose. A pen attached to the filter traces a record of the changes of auroral intensity on a clock-driven chart.

747 Empirical balancing procedure for FP-54. F. C. Armistead. AECD-2619, nd. Decl. June 8, 1949. 6p. Proposed for publication in Rev. Sci. Instruments.

An empirical balancing procedure for the FP-54 electrometer tube is given in detail. It is stated that this procedure can be easily performed by even a person with no understanding of the circuit.

748 Master-slave manipulator. R. C. Goertz. AECD-2635, Mar.7, 1949. Decl. June 24, 1949. 7p.

A device for manipulating a pair of tongs behind a shielding barrier has been built and tested. It is called a Master-Slave Manipulator because the slave tongs move in exact correspondence with a master handle. The "slave hands" follow the master hands in complete synchronism. The test model is entirely mechanical in all functions. The slave tongs are displaced from the master handle by about 3 ft and move in exact synchronism in displacement, rotation and tong opening and closing. This is accomplished by a minimum number of independent motions including three effectively lineal motions, three rotating motions, and one motion to open and close the jaws. There are, therefore, seven completely independent mechanical connections or linkages between the master handle and the slave tongs.

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The entire assembly makes up a manipulating device, the slave end of which can be behind a barrier such as a lead glass window, and which is operated by grasping the master handle and moving it about displacement and rotation in the exact manner in which the slave tongs are desired to be moved.

749 A device to simplify the production of collodion-filmed screens for electron microscopy. Francis W. Bishop. AECU-258, nd. 4p.

A simple device consisting chiefly of a 4-in Pyrex funnel fitted with a T connection and a stopcock is described which makes the preparation of collodion-filmed specimen screens for the electron microscope both convenient and rapid. A photograph of the device is shown.

750 Improved corona triode voltage regulating system. C. M. Turner. AECU-303, May13, 1949. 8p.

A corona triode arrangement with a true grid situated between needles and plate is described and illustrated. A potential applied between the needles and the grid causes a corona discharge from the needles and a fraction of this can be collected on the plate, depending on the potential of the plate and grid transmission. The presence of the grid makes the corona discharge from the needles completely independent of the potential. It is shown how the corona triode is used to regulate the potential of a positive high voltage terminal. A circuit arrangement is shown designed to give control with a negative high voltage terminal.

751 A self-balancing electrostatic potentiometer for pocket chambers. T. A. Rich. AECU-307, Mar. 9, 1949. 20p.

An electrometer is described which has been used as a null detector in a self-balancing electrostatic potentiometer. Design equations are given for the geometry used (which differs from the quadrant type electrometer) and the circuit connections which differ from the usual heterostatic connection. The application of these principles to the construction of a reader for pocket ionization chambers is shown.

752 An electro-mechanical device for solving nonlinear differential equations. Carl A. Ludeke. J. Applied Phys. 20, 600-7(1949) June.

An electro-mechanical device for solving some nonlinear differential equations is described. Solutions are obtained with sufficient accuracy and speed so that an entire domain of solutions can be quickly investigated. The procedure not only avoids the limited point of view inherent in the solutions obtained by most mechanical means, but also retains sufficient accuracy so that its solutions can be used as a starting point for numerical methods if further accuracy is desired. Examples are given of results obtained on some nonlinear differential equations.

753 Electron optics. M. Knoll and E. Kinder. Translated from German by Air Material Command, Wright Field, Dayton, Ohio. Mar. 1948. 66p. (NP-918).

This report compiles the results obtained from a geometric electron optics study. The study is divided into two principle parts: theoretical and experimental principles, and elements of geometric electron optics. Included are investigations on the electron microscope, especially the properties of lenses and immersion systems with a short focal distance, and the phenomena of physical optics. Discussions are also given on the following subjects: potential fields and path determination, reproduction laws and errors, image of electric and magnetic lenses, deflection laws and deflection errors, and single-symmetrical deflector elements.

754 A magnetic field strength meter using the proton magnetic moment. N. J. Hopkins. Rev. Sci. Instruments 20, 401-2(1949) June.

A simple, portable instrument is described which employs the nuclear absorption method and the known value of the proton magnetic moment to determine magnetic field strength. Known fields and geometrical calculations are not required for calibration. The range covered by the present instrument is approximately 3,000 to 19,000 gauss. No upper limit is inherent in the method. Homogeneity

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is required over a small cylindrical volume. Absolute accuracy of better than ±0.2% is obtainable, depending only on a precise measurement of frequency. Higher accuracy is possible in comparing fields and in measuring field changes.

755 The million-volt x-ray plant...its development and application. G. S. Innes. Proc. Roy. Soc. Med. 41, 691-703(1948) Oct.

A history of the development of the million-volt x-ray equipment in use at St. Bartholomew's Hospital in London and the operating characteristics and uses of the apparatus are described. The following topics are discussed in some detail: (1) the design of the million-volt x-ray tube; (2) physical advantages of the new apparatus (including depth dose data and information on the variation in transmission through various body components); (3) ionization levels; (4) treatment planning; and, (5) treatment of large sections and the reduction of damage to vital organs. The following advantages are claimed to be the result when the higher energy x-rays produced by this apparatus are used: (1) fewer fields are necessary resulting in a simplification of the treatment plan; (2) it is possible either to reduce the dose level on fields passing through easily upset organs or alternatively in some cases to avoid irradiating them altogether, attaining the necessary tumor dose by a less efficient routing of the beams to the lesion; (3) in nearly all cases 6,000 r can be delivered to the lesion in five weeks, no matter how deeply seated it is and regardless of the size of the patient; (4) by careful planning the dosage level can be made to fall off rapidly outside the volume to be irradiated, reducing the ill-effects on the patient; and, (5) bone absorption is less at a million volts than at 250 kv.

756 A vacuum heating, melting, and sintering furnace; its construction and maintenance. W. H. Titorchook and L. S. Foster. Watertown Arsenal Laboratory Report No. WAL-671/61, Apr. 15, 1947. 36p. (NP-866).

The vacuum heating, sintering and melting apparatus is considered under four major subdivisions: (1) the vacuum chamber and its inductor coil, (2) the pumping unit, (3) the pressure measuring equipment, and (4) the high frequency power source. Construction of the apparatus is discussed in the following sequence: power source, inductor coil, vacuum chamber, vacuum manifold, vacuum (butterfly) valve, forepressure manifold, mechanical forepump, vacuum measuring instrumentation, and vacuum manifold extension. Detailed operating procedures of all components are included.

757 Further improvements in magnetic focusing. Larkin Kerwin and Claude Geoffrion. Rev. Sci. Instruments 20. 381-4(1949) June (See also Nuclear Science Abstract 2-1078).

The general theory of magnetic focusing of charged particles in a plane developed in a previous paper (Rev. Sci. Instruments 20, 36(1949)) is extended to asymmetric cases. After developing the general asymmetric case, several particular examples are considered, including one which eliminates second-order aberrations, and requires a smaller magnet than the normal design. Methods of minimizing aberrations are discussed.

758 A mass spectrometer for continuous gas analysis. J. A. Hunter, R. W. Stacy, and F. A. Hitchcock. Rev. Sci. Instruments 20, 333-6(1949) May.

An instrument for recording continuously the relative abundance of gases in a three component mixture is described. High accuracy of analysis has been sacrificed in favor of high speed response since the instrument was designed primarily for use in the investigation of respiratory problems. An instantaneous change in gas composition will appear on the record with a lag of less than 0.2 sec and will require approximately 0.1 sec to settle on this new value.

759 Current radiochemical research at Los Alamos. R. W. Spence. AECD-2625, nd. Decl. June 6, 1949. 7p.

An investigation to discover any changes in the fission yield vs mass curve for U^{235} when the neutron energy was raised from thermal energies to 14 Mev was carried out. It is shown that symmetrical fission is about 100 times more probable for a 14-Mev fission than for a thermal fission. It is apparent also that the heavy peak has shifted to lighter mass numbers, while the position of the

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light peak can be noticed, however; for example, mass 99 has dropped relative to mass 97 by about 8%. Other results are discussed.

An attempt to measure the n, 2n cross section in U^{238} by a determination of the U^{237} atoms formed, and an attempt to determine the mass number of the 17-hr zirconium activity are discussed. No definite conclusions have been reached in regard to these investigations.

760 A note on the fission yield of 67-hr Mo^{99}. E. P. Steinberg. AECD-2626, nd. Decl. June 17, 1949. 1p. For publication in NNES.

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The fission yield of 67-hr Mo^{99} in U^{235} fission has been reported as 6.8%. (Finkle, et al, CN-1958 (1944) Aug. 1). In the calculation of this value, correction was not made for the contribution of the weak radiations (Glendenin, L. E. NNES, Div. IV., Vol. 9B, 7.17.1 (1946)) from 5.9-hr 43^{99} and the value is thus too high. In the present practice (Freedman et al, NNES, Div. IV., Vol. 9A, Chap. VII), an Al absorber of ~12.5 mg/cm^2 thickness is used to cut out the 43 radiations in the counting of 67-hr Mo^{99} samples. By applying the appropriate absorption correction (T 1/2 = 55.0 mg/cm^2) to the activity observed at an absorber value sufficient to remove all 43 radiations, the true activity of the 67-hr Mo can be obtained. This is then corrected for decay, fractional saturation, geometry, chemical yield, etc. and compared with a fission yield standard in order to obtain the fission yield. A recalculation of the 67-hr Mo^{99} data applying these corrections results in a fission yield of 6.2% (relative to that of 6.1% for the 12.8-day Ba^{140}.

761 A summary of nuclear chemistry work at Argonne. Martin H. Studier. AECD-2627, nd. Decl. June 13, 1949. 4p.

Among the goals of the Argonne program are the following: (1) The completion of information on the capture cross section of all the longer-lived isotopes among the fission products found in a reactor. Measurements are reported for Cs^{137}, Pr^{141}, Sr^{190}, and I^{129}. (2) The clarification of information concerning the various tin isotopes, most of which are given uncertain classification in the table of Seaborg and Perlman. (3) The investigation of isotopes in the heavy region which can be produced by neutron irradiation or by cyclotron bombardment.

762 Neutron age calculations in water, graphite, and tissue. A. S. Householder. AECD-2633, nd. Decl. June 17, 1949. 7p.

A brief summary of the slow-neutron problem is reported. This amounts to the use of Monte Carlo for solving Milne intergral equation. Life histories were obtained by using the Goertzel-Spinrad nomogram. The calculations by hand of 100 neutrons from a 10-Mev monoenergetic isotopic plane source in an infinite water medium are reported. The results were somewhat anomalous. One possible explanation might be that the digits were not truly random, but it seemed more reasonable to attribute the anomaly to the small size of the sample. The anomaly was this, that whereas the variance of the Z-distributions should rise rapidly at first, then more slowly, becoming almost constant at high lethargies with a curve that is everywhere concave downward, the curve had initially an upward concavity and only began to behave properly at energies below one-tenth the source energy. In terms of estimated errors of estimate, the anomaly lies in the realm of about 1% probabilities. The tables give the estimated standard errors of estimate of the mean of the second and third moments about the mean for the u-distribution, and of the second moments for the Z-distributions, all in the terms of per cents of these moments.

Some calculations for graphite are mentioned. The cross sections were taken to be independent of energy, which, along with the fact that only one type of scatterer was involved and absorption was neglected, facilitated the computations considerably. Because of the constancy of the cross sections it was not necessary to specify the initial energy and the history was terminated upon reaching 1/100 the initial value. A study is underway to estimate collision densities in tissue from high energy, parallel-beam sources.

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763 Angular yield of neutrons from the D-D reaction. G. T. Hunter and H. T. Richards. AECU-264, nd. 1p.

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The Wisconsin electrostatic generator was used to furnish deuterons whose average energy in the target was varied from .5 Mev to 3.7 Mev. A "thin" deuterium gas target was used, the deuterons being admitted through a .00005-in. nickel foil. The neutrons were detected by an energy insensitive long counter placed 1 meter from the target. The neutron yield was measured at angles from 0 to 165 degrees in the laboratory system and then corrected to the center of mass system. The yield in the center of mass system was found to be of the form $N(\theta) = K(1 + A \cos^2\theta + B \cos^4\theta + C \cos^6\theta)$, the total yield being essentially constant above 1 Mev. The coefficient A was found to be negative above 1.4 Mev. An appreciable amount of $\cos^4\theta$ was needed at all energies. At energies above 2.5 Mev, best fit of data required also the inclusion of a small amount of the $\cos^6\theta$ term. Disintegration protons at 90 degrees were observed by a proportional counter as a monitor of the reaction.

764 Total cross section measurements for fast neutrons. C. K. Bockelman, R. E. Peterson, R. K. Adair, and H. H. Barschall. AECU-288, nd. 10p. 7 figures.

The total cross sections of Zr, Ag, In, Sb, I, Ta, and Pb have been measured as a function of neutron energy in the energy range from 20 kev to 1600 kev. A spread in energy of 30 kev was used up to 200 kev, and a spread of 70 kev above this energy. Indications of structure were found in Zr and Pb. The results are compared with the predictions of the statistical theory.

765 The augular distribution of the photoneutrons from beryllium. B. Hamermesh, M. Hamermesh, and A. Wattenberg. AECU-302, Apr. 28, 1949. 11p.

The angular distribution of the photoneutrons from beryllium has been studied for γ-ray energies of 1.70, 1.81 and 2.76 Mev. The distribution was found to be spherically symmetrical for the 1.70- and 1.81-Mev γ-rays. The 2.76 Mev γ-ray yields a distribution of the form $a + b \sin^2\theta$ with $a/b = 1.2$.

766 Protons and deuterons knocked out of nuclei by 90-Mev neutrons. Herbert Frank York, Jr. AECU-316, nd. 90p.

In this experiment, measurements were made of the angular and energy distributions of a mixture of several types of particles all of which have energies ranging from about 20 to 100 Mev. The procedure used was to measure the spectra at each of a series of angles, the angle under consideration being fixed by geometry. For a known type of particle (i.e., proton, deuteron, or triton in the present case), the energy was determined by a measurement of its H_ρ, range, or specific ionization, and conversely, for a particle of known energy the type was determined by any one of these three measurements However, in the case of a mixture of particles, it was necessary to measure simultaneously any two of the above quantities in order to determine both type and energy. Most of the measurements described here were made with the H_ρ specific ionization combination. The H_ρ range combination was used as a rough check on the results. As an extra check on some of the results, all three quantities were measured simultaneously in a few cases. The nuclei investigated were carbon, copper, and lead.

767 Nuclear cross sections for 95 and 270-Mev neutrons (measured with bismuth fission chambers). J. DeJuren, N. Knable and B. Moyer. AECU-327, nd. 1p.

This document is in abstract form; it is reproduced below in its entirety.

Total and inelastic nuclear cross sections for 95- and 270-Mev neutrons have been measured using bismuth fission chambers. The 95- and 270-Mev neutrons are produced by bombarding a Be target with 190-Mev deuterons and 350-protons, respectively, in the 184 in. cyclotron. Total cross sections were measured using good geometry, and a special geometry was devised so that inelastic and total cross sections could be measured simultaneously. The total cross sections of the elements measured from deuterium to tin at 270 Mev are all .57 to .58 times their values at 95 Mev. The ratio of inelastic to total cross sections was about 0.40 for heavy elements at 95 Mev. At 270 Mev, σ_i/σ_t is nearly 0.50 for both Cu and Pb, which is the value obtained for opaque nuclei at "low" neutron energies.

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768 Total cross sections of nuclei for 280-Mev neutrons. R. Fox, C. Leith, K. McKenzie, and L. Wouters. AECU-328, nd. 1p.

This document is in abstract form; it is reproduced below in its entirety.

The measurement of 280-Mev neutron cross sections of various nuclei will be described. The neutron beam used results from 350-Mev protons in the 184-in. cyclotron striking a 2-in. Be target. The neutron detector consists of a double coincidence anthracene scintillation counter telescope which counts recoil protons scattered at 15 degrees from a paraffin cylinder placed in the collimated neutron beam. A 2-in. Cu absorber placed between the two counters assured that only protons of energy greater than 250 Mev are counted. The cross sections for all nuclei measured from Li to Pb are smaller than the corresponding cross sections measured at 90 Mev (Cook, et. al., Phys. Rev. 75, 7(1949)) by factors between 0.5 and 0.6.

769 Total cross sections of nuclei for 40-Mev neutrons. R. H. Hildebrand and C. E. Leith. AECU-332, nd. 1p.

This document is in abstract form; it is reproduced below in its entirety.

The measurement of the 40-Mev neutron total cross sections of various nuclei will be described. The 40-Mev neutron beam is produced in the 184-in. cyclotron by the stripping (R. Serber, Phys. Rev. 72, 1008(1947)) of 90-Mev deuterons in a 1/2-in. thick Be target. The method of detection is that used by Cook, McMillan, Peterson, and Sewell (Phys. Rev. 75, 7(1949)) in making similar measurements for 90-Mev neutrons. The neutron intensity is measured by counting the 20.5-min C^{11} position activity resulting from the C(n,2n) reaction in carbon discs. The threshold for this reaction is about 20 Mev. The cross section at 40 Mev will be compared to those at other energies. In the region of O, Mg, and Al the cross sections are only slightly smaller than those measured at 14 Mev, whereas, for nuclei heavier than Sn the cross sections are closer to those measured at 90 Mev.

770 Cloud chamber studies of the stars in oxygen. James Frueh Tracy. AECU-342, nd. 105p.

It was desired to ascertain how readily and with what degree of certainty it was possible to analyze the disintegrations (i. e., "stars") produced in a Wilson cloud chamber by high energy bombarding particles (neutrons). It was desired to determine the initial nucleus, the mass and charge of the resulting fragments, their energies, etc. A second objective was a knowledge of oxygen disintegrations, in particular, as a preliminary to the investigation of disintegrations in other gases.

It has been possible to obtain a few general conclusions from this study which are as follows: There has been no evidence to disprove and some to substantiate the view that all but a few per cent of the kinetic energy of the incident neutron is accounted for by the binding energy of the disintegration plus the sum of the star fragment kinetic energies. In most disintegrations one or more secondary neutrons are present. Nothing can be said about the number of secondary neutrons usually present. There is evidence in a few cases that no or at most one secondary neutron resulted from the disintegration. There is no evidence to disprove and a little to substantiate the assumption that a disintegration fragment may have any combination of charge and mass within the limitations of the charges and mass units present initially and the fact that it must exist long enough (have a long enough half-life) to be observed. The study of the helium stars yielded strong evidence that a significant number of the prongs were deuterons (H^2) and possibly tritons (H^3). There appear to be no special characteristics which would easily distinguish oxygen stars from carbon stars which have been initiated by 90-Mev neutrons.

771 Energies of neutrons from MsTh-D, La-D, Y-Be, and Sb-Be photo-neutron sources. A. O. Hanson. Phys. Rev. 75, 1794-99(1949) June 15.

The energies of neutrons from several neutron sources have been compared with those of neutrons of calculable energies from the Li(p,n) reaction by observing the maximum pulse heights of proton recoils in a hydrogen-filled proportional counter. The values found for the average neutron energy from the various sources are: MsTh-D, 197 $\pm$ 10 kev; MsTh-Be, 827 $\pm$ 30 kev; Y-Be, 158 $\pm$ 5 kev; La-D, 151 $\pm$ 8 kev; and Sb-Be, 24 $\pm$ 3 kev. These values are consistently lower than those expected from the measured γ-ray energies and the usually accepted photo-neutron thresholds. Better

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agreement could be obtained if the photo-neutron thresholds of deuterium and beryllium were taken as 2.23 and 1.68 Mev. The energies of the effective γ-rays from Y^{88} and La^{140} are obtained from the neutron energies and are found to be 1.86 Mev and 2.53 Mev, respectively.

772 High-energy electron accelerators as pulsed neutron sources. J. D. Cockcroft, J. C. Duckworth, and A. W. Merrison. Nature 163, 869(1949) June 4 (2 Letters to the Editor).

Cockcroft discusses the possibility of using high-energy electron accelerators as pulsed neutron sources in one letter; in a second letter investigations along these lines are reported by Duckworth and Merrison. Measurements to investigate the potentialities of this method were made using a linear electron accelerator providing 100 ma peak current in a 2-μ sec pulse of electrons of 3.2 Mev energy. The electrons were absorbed in a lead target, and the resulting x-radiation was absorbed in a container filled either with heavy water or with beryllium scraps. The neutrons produced were absorbed in manganese sulfate solution in a tank surrounding the container and the neutron production was measured by comparing the activity of the manganese solution with that produced by a 200 mg Ra-Be source inserted in place of the container. The peak neutron production was measured as $2 \times 10^{12} \pm 25\%$ neutrons/sec as compared with a value of 3×10^{12} neutrons/sec predicted by the Bethe-Heitler theory for a heavy water target. From these results it is concluded that this method holds great promise for time-of-flight measurements and that with higher energy linear accelerators, measurements with good resolution should be obtainable up to neutron energies of 20 kev. Moreover, the high electron currents available at low pulsing-rates on machines using Marx-type generators might provide neutron sources of sufficient strength to work up into the 100 kev region.

773 Introduction to the theory of diffusion and slowing down of neutrons. Part II. R. E. Marshak, H. Brooks, and H. Hurwitz. Nucleonics 4, 43-9(1949) June.

Some improvements in the theory of the diffusion of neutrons are considered; these include the use of spherical-harmonic and integral equation methods. The former is particularly useful in treating problems in which the scattering is anisotropic or which involve media having different total mean free paths, since in such cases the other methods of treatment break down. On the other hand, in one-velocity problems, where the neutron mean free path is the same throughout space and the scattering is isotropic, it is convenient to use integral equation methods of the type described.

774 Neutron-hydrogen mass difference from the D-D reactions. A. V. Tollestrup, F. A. Jenkins, W. A. Fowler, and C. C. Lauritsen. Phys. Rev. 75, 1947-8(1949) June 15 (Letter to the editor).

The energy release in the reactions $D^2 + D^2 \rightarrow H^3 + H^1 + Q_1$ and $D^2 + D^2 \rightarrow He^3 + n^1 + Q_2$ has been determined by measurement of the energy of the singly-charged H^3 and He^3 ions produced in a heavy ice target at a known angle with a deuteron beam of well-defined energy. The results have been used to evaluate the neutron-hydrogen mass difference as follows:

$$n^1 - H^1 = (Q_1 - Q_2) + (H^3 - He^3).$$

The H^3 and He^3 ions were detected with a scintillation counter. Fluorescent light from the scintillations was collected by a hemispherical mirror, brought out through a Lucite window, and focused on the cathode of a 931-A electron multiplier. The energies of the H^3 and He^3 ions emerging from the target in the angular interval 134.5 to 141.1 degrees were measured by means of a double-focusing magnetic spectrometer. The curves of the number of counts as a function of the energy of the H^3 and He^3 ions, for a bombarding energy of 249 kev, are shown. The following Q-values were obtained as weighted averages: $Q_1 = 4.036 \pm 0.022$ Mev, $Q_2 = 3.265 \pm 0.018$ Mev, $Q_1 - Q_2 = 771 \pm 6$ kev. The results for Q_2 are substantially in agreement with other recent determinations (Argo, Phys. Rev. 74, 1293(1948); Livesey and Wilkinson, Proc. Roy. Soc. (London) 195, 123(1948)). The value of Q_1 is significantly higher than the value $3.98 \pm .02$ previously determined (Oliphant, Kempton, Rutherford, Proc. Roy. Soc. (London) 149, 406(1935); Livingston and Bethe, Rev. Mod. Phys. 9, 245(1937)). From these data, $n^1 - H^1 = 789 \pm 6$ kev. and the binding energy of the deuteron = $2.221 \pm .006$ Mev.

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775 On the production, by a new nuclear reaction, of high energy deuterons by means of fast neutrons. Pierre Cüer, Max Morand, and Lud van Rossum. Compt. rend. 228, 481-3(1949) Feb. 7 (in French).

Previous investigations, by Gardner and Lattes, and by York and Bradner (Bull. Am. Phys. Soc. 24, 19(1949)) of reactions in which a fast neutron bombardment of a nucleus results in the production of a deuteron and a slightly excited state in the nucleus are discussed. The results which have been obtained are summarized and it is concluded that the reaction cannot be explained by the evaporation of the compound nucleus but rather as a matter of the high energy interaction which the authors have previously considered (P. Cüer and M. Morand, Compt. rend. 226, 659(1948)). The physical picture of the reaction is discussed and the similarity of the considerations involved with those entering in the creaction of real mesons in a nucleus is noted. However, the most favorable condition for the formation of the deuteron occurs when the velocity of the nucleon encountered has the same direction as that of the incident nucleon. The production of a deuteron and excited nucleus by cosmic neutron bombardment should also occur and this would explain the considerable proportion of deuterons of high energy which have either appeared as isolated tracks, or in the form of stars.

776 Paramagnetic resonance absorption in crystals colored by irradiation. Clyde A. Hutchison, Jr. Phys. Rev. 75, 1769-70(1949) June 1 (Letter to the editor).

Paramagnetic resonance absorption produced by the irradiation of LiF with neutrons has been observed at 9350 Mc. Single crystals of LiF, which showed no resonance, were irradiated in a flux of approximately 10^{12} neutrons cm^{-2} for periods of time varying from 1 to 24 hr. The observed resonance is consistent with prevalent theories (Seitz, Revs. Modern Phys. 18, 383(1946)) of the trapping of electrons in negative ion vacancies to produce F centers. Other possible sources of such resonance are considered.

777 Scattering of slow neutrons by deuterium gas. J. A. Spiers. Phys. Rev. 75, 1765(1949) June 1 (Letter to the editor).

An elaborate computation on the scattering of slow neutrons by deuterium is described which led to some results which are of interest since they could also have been obtained on the basis of a much simpler picture. Although the thermal velocities of the molecules were taken into account, it is noted that if the molecules had been assumed to be at rest initially only a relatively small error would have resulted in the computed differential cross section. In addition the computed curves closely resemble those obtained from a semi-classical picture in which the incident neutron is scattered by two deuterons at a fixed distance (0.74 A) apart on an axis with fixed but random orientation (Phys. Rev. 75, 1609 (1949)), provided relative changes of phase on scattering by the two scatterers are assumed.

778 Total reflection of neutrons on cobalt. Morton Hamermesh. Phys. Rev. 75, 1766(1949) June 1 (Letter to the editor).

The recently noted possibility of producing polarized neutron beams by reflection from magnetized iron mirrors is discussed (Halpern, Phys. Rev. 75, 343(1949)). It is noted that in the case of Fe, since intensity requirements necessitate the use of a fairly broad band of neutron energies, complete polarization cannot be obtained. However, by reflecting neutrons from a cobalt mirror magnetized along the beam direction an exact analog of the Nicol prism can be obtained and with an arbitrarily broad spectrum of incident neutrons, the mirror will reflect a completely polarized beam.

779 The hypothesis of the 96 elements. 1. New theory of the atomic nucleus. M. Masriera. Anales soc. espan. fis. y quim. 44, B, 795-844(1948).

A further discussion of the nucleus considered as an elementary particle is given and transformations between such particles with conservation of energy, charge, and momentum or spin are considered.

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780 The magnetic moment of Be^9. W. C. Dickinson and T. F. Wimett. Phys. Rev. 75, 1769,(1949) June 1 (Letter to the editor).

The ratio of the frequency of the nuclear magnetic resonance of Be^9 to that of the proton has been measured at 7000 gauss by the magnetic-resonance-absorption method of Pound, Purcell, and Torrey (Phys. Rev. 69, 681(1946)) using an aqueous solution of beryllium fluoride. The magnet and radio-frequency bridges employed were those used by both Bitter (Phys. Rev. 75, 1326(1949)) and Poss (Phys. Rev. 75, 600(1949)) in their recent nuclear-magnetic-moment determinations. However, the accuracy of the present measurement exceeds that of previous measurements with this equipment by about a factor of 10. This was accomplished by taking advantage of the almost integral ratio of the two frequencies and heterodyning the seventh harmonic of the Be^9 frequency with the fundamental of the proton frequency. Using the Millman and Kusch (Phys. Rev. 60, 91(1941)) value of the proton moment $(2.7896 \pm 0.0008)\mu_N$, the Be^9 magnetic moment was found to be

$$\mu(Be^9) = (-)(1.17619 \pm 0.00034)\mu_N$$

If the more accurate value of $(2.7926 \pm 0.0006)\mu_N$, is taken for the proton moment, the following value is obtained:

$$\mu(Be^9) = (-)(1.17747 \pm 0.00027)\mu_N$$

781 The masses of the heavy isotopes. Martin O. Stern. Revs. Modern Phys. 21, 316-21 (1949) Apr.

Radioactive decay data from numerous sources have been used to calculate the atomic masses of the heavy isotopes, i. e., $A \geq 202$, using the Weizsaecker-Fermi formula. The data have been critically surveyed and in some cases they have been supplemented by construction of tentative energy level schemes or by estimates of decay energies. With the adoption of certain assumptions a connection between the different radioactive families was made possible. The masses thus obtained have been tabulated and plotted. Atomic weight 209 on the Weizaecker-Fermi formula is found to be unsatisfactory for the calculation of the masses; the results were found to deviate by as much as 0.020 mass units from those obtained by experimental data (if the latter are adjusted to the calculated ones in the region of Pb). 94 references.

782 Note on proposed schemes for nuclear shell models. Eugene Feenberg, Kenyon C. Hammack, and L. W. Nordheim. Phys. Rev. 75, 1968-9(1949) June 15 (Letter to the editor).

The two papers by the authors (E. Feenberg and K. Hammack, Phys. Rev. 75, 1877(1949) and L. Nordheim, Phys. Rev. 75, 1894(1949)) which cover similar material have been summarized in tabular from to facilitate comparisons between them as well as with the scheme for nuclear shells proposed by Mayer (Phys. Rev. 75, 1969(1949)). In the scheme of Feenberg and Hammack, the rearrangement consists in a pushing up of orbits with radial nodes, such as 2s, 3p, 4d, which progresses more and more for heavier nuclei. Thus, the level scheme is somewhat different for light and heavy nuclei. In Nordheim's scheme, the rearrangement is in the opposite sense; that is, radial nodes are not penalized as much as in a potential well. This may also be described as a discrimination against high orbital momentum states. All three schemes give the empirical shell numbers and a statistical correlation with observed spins and moments.

783 On spins, moments, and shells in nuclei. L. W. Nordheim. Phys. Rev. 75, 1894-1901 (1949) June 15.

The known values of nuclear spins and magnetic moments have been used to assign orbital quantum numbers to the last odd particle. A consistent scheme has been developed which permits the correlation of a wide variety of nuclear data. An interpretation has been obtained of the general trends of nuclear spins, for the particular stability of nuclei containing 20, 50, or 82 neutrons or protons, for the occurrence of isomeric states, and for the allowed or forbidden character of β-decays for nuclei with odd mass numbers.

PHYSICS (continued)

784 Collection of fission product recoils in a flowing gas stream and related pile problems. I. Collection of activity in a circulating He system. Nathan Sugarman. AECD-2622, nd. NNES, Div. IV, Vol. 9B Decl. June 10, 1949. 24p. For publication in NNES.

An experiment was designed to measure the gross radioactivity introduced into a circulating gas system exposed to bare U from the fission products recoiling from the metal surface. The time interval between the active material and the detecting apparatus was 2 sec, the cycle time 14 sec, and the duration of the irradiation 1 hr. The specific results obtained and the extrapolations made therefrom are thought to be valid as to the order of magnitude of the activity expected in large systems for long irradiation times.

785 Pile theory notes for M. I. T. seminar, part II. F. L. Friedman and B. T. Feld. AECD-2638, nd. Decl. July 1, 1949. 46p.

The following topics are discussed: a program for testing the pile theory, the detection of charged particles, the radioactivation of foils in a pure thermal neutron density, the cadmium difference method, resonance activation as a measure of slowing down neutron density, measurement of pile power levels, measurement of η (the number of neutrons released per fission), the calibration of neutron sources, the slowing down density around a point source of the neutrons which are emitted at a high energy, the measurement of the resonance escape probability, the measurement of L^2 (the thermal diffusion length), the measurement of the thermal utilization of neutrons, a survey of nuclear cross section results, neutron velocity selectors, and special techniques for detecting neutrons of certain definite energies.

786 Experimental facilities to be available at the brookhaven nuclear reactor. AECU-291, nd. 1p.

This document is in abstract form; it is reproduced below in its entirety.

The Brookhaven reactor, which will be available for experiments the latter half of this year, is air cooled, graphite moderated, and fueled with normal uranium. With this design a number of simultaneous independent experiments can be performed. For experiments, one hole 12 in. square into the center of the reactor, and several 4-in. square holes at various levels, running 38 ft clear through the graphite and both shields, permit the installation of apparatus inside the pile or allow a collimated neutron beam out. A number of automatic devices are installed allowing controlled irradiation of samples for periods as short as 10 sec. The top shield consists of 4-ft square blocks removable to accommodate thermal columns or other large equipment. The thermal neutron flux available ranges from 5×10^{-12} at the center to about 10^{11} neutrons/cm^2 sec at the graphite surface. Laboratories specially designed for physical, chemical, biological, and medical research, accommodating more than 80 scientists and technicians, are a part of the reactor building. A hot laboratory in which amounts of radioactive material emitting up to 50 curies of 2 Mev gammas can be manipulated, is being built nearby.

787 Collected technical reports from Vol. I, numbers 1-20 of the Rocket News Letter. Edited by Norman Bowman, published by the Chicago Rocket Society, 1949, 57p.

Since many of the issues of Rocket News Letter, Vol. I are out of print, the papers of a technical nature which appeared in the first 20 numbers of that volume have been collected and reprinted. Among the papers included are the following: "Theory of atomic rocket fuels," by Wayne Proell; "Gamma-ray shields for rocket ships," by Wayne Proell; and "The metallurgy of the combustion chamber of an atomic rocket," by George Whittington.

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788 High energy particles as rocket fuels. Norman Bowman. Rocket News Letter 2, 9-14(1949) May.

Calculations have been made concerning the possible use of high energy particles to achieve the "escape velocity" of 36,710 ft/sec necessary to propel a rocket or "space ship" out of the earth's field (under the most favorable conditions, i. e, vertical flight at the equator). For particle velocities approximating the velocity of light, the increase in mass (according to the Einstein equation) becomes very large; the velocity range explored is that between the present exhaust velocities of 10^5 cm/sec and velocities of about 10^9 cm/sec. The velocities of various accelerated particles at different energies have been tabulated and a table is also shown of the calculated rate of fuel consumption of various particles required to give a 1 G thrust to a 1,000 kg space ship as a function of the particle energies. More detailed calculations are given in the case of hydrogen, which is considered one of the most practical possibilities. It is noted that in all cases it appears that the fuel percentage of the total rocket weight appears favorable. The practical problem of accelerating the necessary 156 gram/sec of hydrogen with a 250,000 ev accelerator is considered and shown to be unfeasible. However, the author concludes that the fundamental problem of extended space flight can be solved by the use of relatively small amounts of fuel obtained by means of high energy particles and it is suggested that the solution of the problem may be the direct utilization of fission fragments for rocket propulsion.

789 Is the nuclear-powered rocket feasible? H. S. Seifert. Phys. Today 2, 7-13(1949) May.

Current problems in the development of conventional-type rockets are discussed and the possibility of powering rockets with nuclear energy is considered. The problem of building structures to contain higher and higher temperatures is noted. Some of the difficulties which would be encountered in using the scheme (with liquid hydrogen as the working fluid) which the author believes the most feasible for immediate development are described. Also considered as an "entertaining subject for speculation" is the possibility of a "pure photon" rocket propellent, i.e., the use of matter which has been completely converted into energy which flows out of the rear of the rocket. It is concluded that the nuclear rocket is one of the less practical applications of nuclear energy since it gives rise to problems which are more numerous and difficult to solve than those arising in connection with the nuclear electric power plant and nuclear ship.

790 Disintegration of B^{10} by protons. W. E. Burcham and Joan M. Freeman. Nature 163, 167(1949) Jan. 29 (Letter to the editor).

Using the magnetic analyser and photo-electric multiplier previously described (Freeman and Baxter. Nature 162, 696(1948)), the α-particles from the reaction $B^{10} + H^1 \rightarrow Be^7 + He^4$ have been investigated. A curve of the number of particles counted as a function of the current through the analyser coils, for a proton energy of 530 kev, is shown. The mean range of the α-particles from the reaction was determined as 0.56 ± 0.01 cm which corresponds to an energy of 1.04 ± 0.06 Mev, as

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compared with the value of 1.15 Mev predicted from the masses involved (Bethe, "Elementary Nuclear Theory," 124 (Wiley, New York)). A determination of the energy release of the reaction was also made, and a value of 1.05 ± 0.07 Mev was obtained. It is noted that although it is possible that the Be^7 nucleus is formed in an excited state no evidence of α-particles corresponding to transitions to the ground-state in numbers exceeding 10% of the main group at the particular angle of observation (83 degrees with the incident protons) was found.

791 Disintegration of separated isotopes of magnesium by deuterons. H. R. Allan, Christiane A. Wilkinson, W. E. Burcham, and C. D. Curling. Nature 163, 210 (1949) Feb. 5 (Letter to the editor).

Previous interpretations concerning the deuteron bombardment of magnesium, resulting in the emission of three groups of protons (Proc. Roy. Soc. (London) A194, 131(1948)), have been revised on the basis of further investigations using the separated isotopes, Mg^{24}, Mg^{25} and Mg^{26}. Number-range curves for the protons emitted, using the three targets, are shown. The Q-value previously given for Mg^{24} (d,p) Mg^{25} was confirmed. The groups observed for Mg^{25} are attributed to contamination with Mg^{24}. In the case of the third isotope, Mg^{26}, a Q-value of 4.21 ± 0.1 Mev was obtained for the reaction $Mg^{26}(d,p)Mg^{27}$, as compared with the previously quoted value of 4.05 Mev. The separated targets have also been used to confirm the reaction Mg^{26} $(d\alpha)Na^{24}$.

792 The emission of protons from boron and argon on bombardment with Po α-particles. R. R. Roy. Phys. Rev. 75, 1 75-6(1949) June 1 (Letter to the editor).

The variation in the yield of protons with the incident α-particle energy has been investigated for the reactions $B^{10}(\alpha,p)C^{13}$ using a cloud chamber. Earlier reports had indicated that the compound nucleus N^{14} may decay with the emission of a proton leaving the final nucleus either in the ground state or in one of its excited states. The angular distribution of the 86 protons (obtained in the course of 700 photographs) arising from various states has been investigated. The Q-values calculated from the energies of the emitted protons and incident α-particles are given in tabular form and show close agreement with the results of earlier investigations; curves of the angular distributions of the protons having Q-values of 0.42 and 0.09 Mev, respectively, are shown. For the second and third excited states, the distributions observed were isotropic; from this it is concluded that the angular momentum of the incident α-particle is $l = 0$ and consequently only an S-wave is involved in this interaction. Although the Q-value is 3.71 Mev, indicating that the reaction $A^{40}(\alpha,p)Sc^{43}$ is possible, no protons were detected when argon was bombarded with 4.7-Mev α-particles. This confirms the results of previous investigators. (E. Pollard and C. J. Brasefield. Phys. Rev. 51, 8(1937)).

793 Energy levels in Ca^{41} and the mass difference between A^{40} and Ca^{40}. Vance L. Sailor. Phys. Rev. 75, 1836-9(1949) June 15.

The reaction $Ca^{40}(d,p)Ca^{41}$ was studied and Q-values of 6.17, 4.22, 3.76, 2.31 Mev were found. Four additional Q-values 3.2, 2.9, 2.7, 2.5 Mev are probable. The mass increment $(A^{41} - A^{40}) - (Ca^{41} - Ca^{40}) = 2.54 \pm 0.03$ mMU was obtained by comparing the end groups of the two reactions

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$A^{40}(d,p)A^{41}$ and $Ca^{40}(d,p)Ca^{41}$. These data combined with data from two other nuclear reactions give the mass difference $Ca^{40} - A^{40} = 0.27 \pm 0.21$ mMU, indicating that A^{40} is slightly more stable than Ca^{40}. This mass difference is compared with data on the radioactive decay of K^{40}, showing that the assignment of the 1.55-Mev γ-ray to $K^{40} \longrightarrow A^{40}$ K-capture process is reasonable.

794 Short range alpha particles from fluorine and lithium bombarded by protons. W. E. Burcham and Joan M. Freeman. Phys. Rev. 75 1756-7(1949) June 1.

Previous data (Walker and McDaniel. Phys. Rev. 74, 315(1948)) on the energy of the γ-radiation emitted in the bombardment of fluorine and lithium by protons have been extended. Alpha particles corresponding to the emission of 7-Mev γ-rays have been observed; the α-particles were resolved magnetically from protons scattered from the target and were detected by means of a fluorescent screen and a photoelectric multiplier. Curves are given of the number of α-particles as a function of analyzer magnet current for the $F^{19}(p\alpha,\gamma)O^{16*}$ reaction for proton energies of 867 and 932 kev and for the bombardment of lithium with 440-kev protons. The Q-values deduced for the α-particle groups from fluorine are given in tabular form. The results suggest that the excited state in which the O^{16} nucleus is left in this reaction is not the same at all resonances; the results could be explained by the existence in the oxygen nucleus of levels at 6.94 and 7.15 Mev above the ground state, in addition to previously known levels. If this is so, the energy of the γ-radiation observed at the 932- and 665-kev resonances should be 7.15 Mev and that of the γ-radiation at the 867-kev resonance should be 6.94 Mev. The ratio of the two groups of α-particles from fluorine is compared with the previously observed γ-ray intensity ratio (Rasmussen, Hornyak, and Lauritsen. Phys. Rev. (to be published)) and it is noted that the variation in the former with proton energy for the most part is in agreement with the predicted varying penetrability of the barrier of the O^{16*} nucleus for the two α-particle groups. In the case of the bombardment of lithium with protons, the α-particles from the excited state of Be^8 which is produced from a group centered at an energy of 1.38 ± 0.08 Mev. The energy of the excited state of Be^8 is determined as 2.6 ± 0.2 Mev, and the width is 0.9 ± 0.1 Mev.

795 Theory of proposed reactions involving polarized protons. Lincoln Wolfenstein. Phys. Rev. 75, 1664-74(1949) June 1.

Since the use of fast polarized bombarding particles in nuclear reactions provides a possible tool for studying the spin-dependence of nuclear interactions, the general properties of such reactions are considered and in particular the reactions possible using polarized protons are discussed. The results obtained for incident neutrons or protons are summarized in terms of L_{max}, the value of the maximum partial wave which must be considered. The following reactions involving polarized protons are shown to be possible: (a) production of polarized protons by the (n,p) reactions on N or He^3 using polarized thermal neutrons, (b) detection of polarization by means of the $Li^7(p,\alpha)\alpha$-reaction, and (c) production or detection by the resonance scattering of protons from helium. Considering these reactions alone and exploring the fundamental limitations on intensity, it is found that the intensity problem appears to be least critical if (c) is used for both production and detection. The polarization effect usually depends on at least one parameter which does not affect or affects much less critically the unpolarized result. The polarization effect caused by the spin-dependent Coulomb scattering is calculated and found to be less than 5% for atomic number Z less than 5, except for special cases. It is noted that protons retain their polarization while being slowed down.

796 High current high voltage gas discharge tube. W. R. Baker, Q. A. Kerns, Jack Reidel, and R. F. Edwards. AECD-2634, July 14, 1948. Decl. June 24, 1949. 16p.

This paper describes a high current, high voltage gas discharge tube for use on a high voltage pulse generator to drive the 184-in. Cyclotron Electric Deflector. The tube is continuously pumped and is filled with helium at 200 to 1000 microns pressure. An arrangement of electrodes, in which the firing mechanism is outside the two main electrodes, results in a tube with the following performance: peak current 100,000 amperes, plate voltage variable from several hundred volts to 20 kv,

PHYSICS (continued)

time jitter of less than 0.005 μsec, lead inductance less than 0.005 μhr, repetition rate 180 pulses per second, pulse length 0.1 μsec for above data but longer at reduced currents, and peak power 1000 megawatts.

797 Survey of treated water supply system for the 184-in. [Synchrocyclotron] area and vicinity. Carl T. Grauer. AECU-253, Feb. 23, 1949. 13p.

The data were collected for the purpose of consolidating information relating to the treated water supply as used for electrical cooling purposes. Included are expense items, data on contamination and electrical requirements, and recommendations for use as a guide in future operations.

798 Dynamic magnetic measurements on cosmotron magnet model. G. K. Green, H. S. Snyder, and L. W. Smith. AECU-263, nd. 1p.

This document is in abstract form; it is reproduced below in its entirety.

The pulsed magnet of a proton synchrotron type accelerator must maintain an accurately shaped field over a wide range of value (275 to 14,000 gauss in the Brookhaven Cosmotron). One-third scale models of a C-magnet are subtending 7 1/2 degrees have been measured dynamically over a scaled operating cycle. Measurements of the first few milliseconds of the pulse cycle indicate that half-inch lamination thickness can be used, and that the remanence of the magnet almost exactly cancels the eddy current transient. At higher fields the effects of saturation are so large as to require heavy compensating currents on the pole faces. The measurements have been made with a differential flux coil and integrator technique. Steady state measurements of the model are made with a servo-flux meter of variable magnification arranged to draw field curves automatically.

799 High voltage pulse transformer designs at University of California Radiation Laboratory. W. R. Baker, R. F. Edwards, Q. K. Kerns, and J. Reidel. AECU-304, May 20, 1949. 39p.

This paper describes several high voltage pulse transformers, developed at the Radiation Laboratory of the University of California for use on particle accelerators. Pulse transformers described are a 100 kv synchrotron injector transformer, a 500-kv iron and air core synchrotron injector transformer, a 100-kv spark gap trigger transformer, a 140-kv 184-in. cyclotron deflector transformer, a 80-kv insulation test transformer, and a 400-kv multiple core transformer.

800 The dynamics of a synchrotron with straight sections. Nelson M. Blackman and Ernest D. Courant. AECU-322, Mar. 7, 1949. 14p.

The equations describing the "betatron" and "synchrotron" oscillations of a particle being accelerated in a synchrotron having straight sections are obtained. In particular, the relative increase in the ratio of either (vertical or horizontal) betatron-oscillation frequency to the frequency of revolution is found to be approximately half the ratio of the total length of straight sections to the orbit circumference. The effect of magnetic fringing fields is considered. With regard to the synchrotron phase oscillation, it is found that the criterion of nonrelativistic adiabatic damping is no longer that n exceed 2/3 but that it exceed 2/3 by at least 1/3 of the ratio of the total length of the straight sections to the orbit circumference. "Viscous" damping of the synchrotron oscillations is also obtained if there is a radial gradient in the accelerating voltage.

801 University of California proton synchrotron (bevatron). George M. Farly. AECU-326, nd. 2p.

This document is in abstract form; it is reproduced below in its entirety.

The proton accelerator now under construction at the U. C. Radiation Laboratory will make available nuclear particles with kinetic energies in the range exceeding one Bev (billion electron volts). This is the reason why the name Bevatron has been chosen for the University of California machine. The principal limitation in the energy attainable in this type of accelerator lies in the size

PHYSICS (continued)

and cost of the electro-magnet and of the magnet power supply. The magnetic field must be pulsed for each acceleration cycle. During each pulse the magnetic field will absorb 80,000 kilowattseconds of energy from the power supply and the peak power demand from the supply will be 100,000 kilowatts. Most of this energy will be returned to the supply after each pulse and stored as kinetic energy in rotating fly wheels. The cycle will be repeated ten times per minute. Two motor-flywheel-alternator sets will be required for the magnet supply. Each alternator is built with four separate star connected three-phase windings which are displaced to be equivalent to a twelve-phase machine. Each winding will be connected to a group of six ignitron rectifiers having a common cathode connection. The ignitrons can be excited by suitably phased signals to operate as rectifiers when energy flow is from flywheel to magnet, or as inverters when energy flow is from magnet to flywheel. Any net loss of energy will be supplied from the PG & E system via wound rotor induction motors. The magnet will be arranged in four, 90-degree quadrants connected by straight sections containing no magnetic field. A continuous vacuum chamber will link all sections and define the channel in which particles must be guided during the acceleration. Protons will be injected into the vacuum chamber with an initial velocity appropriate to the strength of the magnetic field at the instant of injection. Almost simultaneously an electric accelerating section will be energized and some protons will pull into step with the electric accelerator. From then on, if the frequency of the oscillator is programed according to the strength of the magnetic field it will be possible to accelerate particles to an energy corresponding to the peak value of the magnetic field and the radius of curvature of the accelerator. For 50-foot radius of curvature and 16 kilogauss the corresponding proton energy is 6.4 Bev. The protons will travel about 300,000 miles during the 1.85-sec acceleration interval. An experimental quarter scale accelerator is now operating and protons have been injected at 0.7 Mev and accelerated to 6.5 Mev. The machine is providing valuable information regarding injection problems, scattering losses, and the effect of aperture dimensions on beam intensity. The aperture dimensions that will permit magnetic field intensities of 16 kilogauss to be attained are 1 ft high by 4 ft wide. Model test will reveal the critical factors such as frequency tracking, vacuum conditions, injection energy, etc., which will be necessary to insure a significant intensity of 6-Bev protons when the Bevatron is completed.

802 Design study for a 3-Bev proton accelerator. M. S. Livingston, L. J. Haworth, J. P. Blewett, and G. K. Green. AECU-337, nd. 50p.

The synchrotron principle of phase-stable acceleration in a magnetic field can be used to accelerate protons to energies well in excess of one billion electron volts (Bev). Energies of this magnitude are needed in order to study the processes of formation of mesons. From such studies it is anticipated that much can be learned regarding the role of mesons in nuclear forces. The simplest nuclear process — the bombardment of single protons by other, highly energetic protons — will be the most informative; in this process less than half of the kinetic energy is available for meson formation. The threshold for production of π mesons (about 300 times electron mass) by this process would be about 300 Mev, and for adequate intensities an energy of 600 Mev is desirable. Production of multiple meson showers or of possible heavier mesons (such as the 700 mass mesons reported in some cosmic ray observations) would require even higher energies. Furthermore, an energy greater than the 2 Bev theoretical threshold for heavy particle creation is certain to yield interesting and significant results. Accordingly, the design energy for the first Brookhaven proton accelerator (to be called a "Cosmotron") has been set at 3.0 Bev. This paper is a report of the present design status, and a discussion of the factors leading to the design. Magnetic accelerators for electrons, such as the betatron or the synchrotron, have a practical energy limit of the order of 1 Bev due to the rapid onset of radiation losses. Linear accelerators are in too early a stage of development to permit prediction of their possibilities in the Bev-range. The synchro-cyclotron requires a solid core magnet which, at these energies, becomes exorbitant in weight and cost. A ring magnet is indicated to reduce cost, and protons can be used to avoid the radiation loss limitation. Under these conditions, the synchrotron principle provides a practical method of acceleration of particles to energies of several Bev.

PHYSICS (continued)

803 Radio frequency accelerating system for the 300-Mev synchrotron. Craig Spencer Nunan. AECU-341, Mar. 26, 1949. 121p.

The University of California 300-Mev synchrotron employs a toroidal quartz vacuum chamber. A 45-degree section of the quartz donut has been metallically coated and scribed to form a quarter-wave coaxial resonator for operation at a nominal frequency of 47.7 Mc. An arrangement of scribe lines has been developed to give a Q of 445, with eddy current fields uniform enough to provide a 3-in. usable radial aperture. An oscillator has been developed to provide 5 kv peak r-f volts across the quartz resonator gap over a frequency range sufficient to tune the synchronous electron orbit to either limit of the radial aperture. R-f voltage pulse shaping has been tried, with a resultant 20% increase in x-ray beam intensity. About 80% of the betatron beam is caught and accelerated by the r-f pulse. None of the r-f pulse parameters have been found to be particularly critical. When twice minimum r-f gap voltage is used, an inconsequential fraction of the total x-ray beam is produced during the r-f pulse, indicating that most of the electrons captured from the betatron beam are accelerated to full energy. Good acceleration can be obtained over an r-f pulse starting time range of 5 μsec and frequency range of 0.5 Mc.

804 Design of cyclotron vacuum system. David Rose. Carnegie Institute of Technology Technical Report No. 4, nd. 43p. (NP-883).

Methods for computing pumping speeds of complex geometries are presented. A reasonable approximation of vacuum equipment required is considered. Conductance of ducts of noncircular cross section is considered and a summary of conductance formulae is presented in appendixes. Graphs and schematic drawings of a vacuum system are included.

805 Discussion on "A 20-M.eV Betatron." F. K. Goward and J. Dain. Proc. Inst. Elec. Engrs. 96 Part 1, 85-7(1949) Mar.

The authors have submitted a comment on a previous paper by Bosley et al (Proc Inst. Elec. Engrs. 95 Part 1, 352(1948)). These authors had described measurements made to determine the position of the equilibrium orbit in a betatron; the method used determines the radius at which the induced tangential field strength had a minimum value. This method is of restricted application, but it is observed that the results may be interpreted more accurately by the use of the correlation between plots of axial magnetic field and induced tangential field strength. It is possible to determine the consistency of the authors' results by deriving the one plot from the other. Reasonable agreement between theory and practice has been achieved with measurements made on a betatron-started 30-Mev synchrotron described by Fry, Gallop, Goward, and Dain (Nature 161, 504(1948)). The authors of the paper being discussed (i.e., Bosly et. al.) reply to the comments of Goward and Dain and note certain aspects of the accuracy of the data taken which seem to justify their methods.

806 An electro-pneumatic vacuum valve. G. W. Green. J. Sci. Instruments 26, 206(1949) June. (Laboratory and shop notes).

A solenoid-operated electro-pneumatic vacuum valve, designed to protect the Van de Graaff generator against failure of the rotary backing pump mechanical drive from mains supply interruption or belt breakage, is described.

807 A Magnetic Ion Source. Carl Bailey, D. L. Drukey, and F. Oppenheimer. Rev. Sci. Instruments 20, 189-91(1949) Mar.

An ion source for particle accelerators is described. The ion source utilizes an axial magnetic field for collimation of ion and electron beams and provides an electric field-free region for ion formation. The ion source has afforded yields of 500 μamp of resolved protons when used in conjunction with a 200-kv high voltage set. A feature of the ion source is the possibility of obtaining favorable atomic to molecular ion ratios.

PHYSICS (continued)

808 The Ohio State Van de Graaff generator. John N. Cooper. Ohio State University Research Foundation Technical Report 1 (Office of Naval Research Contract), June 30, 1949. 33p. (NP-924).

This report describes the principal components of the generator, discusses certain difficulties which arose in connection with the construction, and outlines the present status of various phases of the project. The generator can produce a beam of magnetically resolved protons in the Mev energy range. The generator is of the horizontal pressure-insulated type and involves no radical departure in design from previously constructed horizontal generators.

809 Abbreviations and terms frequently encountered in foreign and domestic technical and scientific documents, interim edition. Evans Signal Laboratory. nd. 114p. (NP-884).

A list of terms to clarify abbreviations encountered in foreign and domestic technical and scientific documents has been compiled.

810 A graphic-arithmetic method for the simple analysis processes involved in electron movements. Author not given. Translated from German by Air Material Command, Wright Field, Dayton, Ohio, Mar., 1944. 32p. (NP-920).

A graphic method has been developed for simple analysis of the energy processes involved in electron movements. The method deals with finite amplitudes and neglects field distortion. The method is applied to rectangular voltages where the injection current is either constant or rectangular. This leads to the exact mathematical treatment of several problems which yields simple equations for the limit values of the negative alternating field energies and the corresponding plate-electrode distances. With the aid of these results the possible production of 1-cm waves by means of diodes have been investigated.

811 Measurements of gas velocity by ionization techniques. National Research Corporation (Office of Naval Research Contract). Nov. 30, 1948. 11p. (NP-881).

Two complete flowmeters have been designed, built, and made to work at near atmospheric pressure over a velocity range from 10 to 100, and 100 to 400 miles/hr. The 10 to 100 miles/hr apparatus consists, in brief, of a 2-in. diameter pipe with a variable speed air stream blown through it from a vacuum cleaner. Near the end where the air enters the pipe, there is a spark pulsed at the will of a triggering circuit. One foot downstream in the tube is a detection probe. The spark produces a bundle of ions which travel at the stream velocity to the probe. The signal produced by the probe's collection of these ions is amplified and used to re-trigger the spark. The production and subsequent downstream collection of ions is, therefore, self-perpetuating and the repetition rate of the system, which is measured on a frequency meter, is a function of the ion transit time down the pipe, i.e., the velocity of the air stream. The repetition rate can be read even more accurately on an oscilloscope. The 100 to 400 miles/hr flowmeter consisted of a recycling circuit similar to the low speed model, but tests were made with a 4-in. diameter test section having controlled wind velocities up to 400 miles/hr. An operating model is described and results obtained are discussed.

812 Polarization of electrons. Kenichi Shinohara and Norio Ryu. Phys. Rev. 75, 1762(1949) June 1 (Letter to the editor).

Further investigations of the polarization of electrons have been made using the double-scattering method, since the results of previous investigators are not in agreement. A Cockroft-type high voltage equipment was used; the earlier procedure was modified to eliminate the difficulty of the "transmission-reflection effect" (Chase and Cox, Phys. Rev. 58, 243(1940)) and the possible error caused by the slight drift of the accelerating voltage. The results are compared with those of other investigators and with the values predicted by theory. Although the experimental values are smaller than the theoretical values, the results obtained are interpreted as a positive indication of the existence of the polarization.

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813 The resonance method of measuring the ratio of the specific heats of a gas, C_p/C_v. Part V. Section A — An improved apparatus for measuring the ratio of the specific heats of a gas; Section B — The use of electronic counter circuits to measure low frequencies and a variable low frequency oscillator. L. Katz, S. B. Woods, and W. F. Leverton. Can. J. Research 27, 27-38(1949) May.

The authors describe an improved apparatus for the determination of $\gamma = C_p/C_v$, the ratio of the specific heat at constant pressure to the specific heat at constant volume for a gas. The new apparatus is constructed of stainless steel and is designed to withstand pressures up to 100 atm. Provision is made for the control and accurate measurement of the temperature of the enclosed gas over a wide range of temperatures. An electronic counter which will measure time intervals, in units of 10 μsec, from 100 μsec to several seconds in length is described in Section B. An unknown frequency may be determined by measuring the time interval in which a preselected number of cycles occurs. The accuracy is such that frequencies may be measured to within approximately 1 part in 10^5. The circuit for a variable frequency transitron oscillator with an output of 30 w in a range of 15 to 250 cps is shown. The stability of the oscillator is such that the frequency may easily be maintained within 1 part in 10,000 for long periods, and with care in temperature control and choice of electrode voltages much greater stabilities may be obtained.

814 Some results of measurements on a two-dimensional network analog. J. J. Donoghue. North American Aviation, Inc. Report NAA-SR-29, June 20, 1949. 17p.

A two-dimensional network of about 900 carbon resistors has been assembled as the analog of an experiment. Measurements of the resistivity of sections of the network have been made in an indirect manner and compared with direct measurements to determine the systematic errors in the original experiment. The results of the measurements are presented in tabular and graphic form.

815 Specific ionization of fast β-particles in a mixture of air and ethyl alcohol-water vapour. W. J. Beekman. Nature 163, 167-8(1949) Jan. 29 (Letter to the editor).

The effect on the ionization produced by β-particles in air, when the latter is mixed with a vapor of ethyl alcohol and water, has been investigated. For β-particles with a ρH of 1,200, 1,600, 2,000 and 2,400 gauss/cm, the mean specific ionization in ethyl alcohol-water vapor (liquid 60/40 by volume) at 0°C and 1 cm mercury pressure was determined as 3.86, 3.24, 2.71 and 2.45 ion pairs/cm for the probable ionization, and 2.22, 1.68, 1.35 and 1.18 ion pairs/cm for the primary ionization, respectively. From the figures the mean specific primary ionization for a 0.4-Mev β-particle, in this type of mixture at standard conditions, has been determined as 90 ion pairs/cm.

816 Summary of previous investigations on the graphical-mathematical treatment of movements of electrons. Johann J. Saemmer. Translated from German by Air Material Command, Wright Field, Dayton, Ohio, Nov., 1944. 6p. (NP-919).

The graphical-mathematical treatment of the movements of electrons is outlined. A solution of the output problem is obtained in the case of a rectangular symmetrical and finite voltage change in the reaction space. A change in the plate distance results in extreme values for certain definite distances, positive, and negative in turn, of the alternating field output. These distances, the output, and efficiency are represented by simple formulas. Electrons overtaking one another should be avoided as this reduces the negative output. Also included is the case of electron inversion at constant injection current.

PHYSICS (continued)

817 Transport properties of multicomponent gas mixtures. Charles F. Curtiss and Joseph O. Hirschfelder. J. Chem. Phys. 17, 550-5(1949) June.

Equations are derived for the viscosity, ordinary (pressure) diffusion, and thermal diffusion of multicomponent mixtures of gases. The ordinary diffusion velocities are expressed in terms of the usual diffusion coefficients for binary mixtures. The analysis is an extension of the work of Chapman and Cowling (The Mathematical Theory of Non-Uniform Gases, Cambridge University Press, London, 1939). It is shown that the Chapman-Cowling and Enskog procedure can be justified on the basis of a variational principle. This variational principle should be generally applicable to a large class of problems.

818 The counting volume of a cylindrical ionization chamber. Nelson M. Blachman. AECU-259, Feb. 1, 1949. 9p.

The effect on the electric field inside a circular-cylindrical ionization chamber of the end plates is determined. The field lines terminating on the collecting wire at the ends of the guard sleeves determine the volume in which the freed electrons are collected by wire. Formulas and a graph for determining this counting volume are exhibited. In appendexes effects of the sleeves are considered, and the inverse-square integral evaluated for both cylindrical and spherical ionization chambers.

819 Stabilized high voltage supplies for chambers and counters. W. A. Higinbotham. AECU-265, Dec. 1, 1948. 27p.

In this survey lecture the requirements of high voltage supplies used in connection with radiation detectors and the methods commonly used to fulfill these requirements are discussed. Some comparisons between the different types of power supplies and regulating circuits, and some comments about the components and how they affect the operations of various types of detectors are made.

820 Photographic neutron detector of high sensitivity. Thomas H. Johnson. AECU-281, nd. 1p.

This document is in abstract form; it is reproduced below in its entirety.

When a parallel plate Geiger counter containing a quenching vapor is discharged by an ionizing ray a minute spark, characterized by a brilliant glow on the cathode, jumps between the electrodes, at the point where the discharge is initiated. In the present device this phenomenon has been utilized for obtaining a photographic reproduction of the areas of an indium foil which have been activated by a slow neutron irradiation. After activation the indium foil is mounted as the cathode of a counter whose anode is a plate of conducting NESA glass. While the counter is discharging, an ordinary photograph is taken with the camera looking perpendicularly through the glass anode. Since indium, itself, seems unsuitable as a cathode material, although it appears to function satisfactorily as an anode with NESA as cathode, the indium has been covered with a thin foil of pure tin. Satisfactory results have been obtained in preliminary tests with shadow graphs of a cadmium mask. The smearing of the spark pattern due to scattered beta rays from the indium and to secondary x-rays has been studied by means of a composite cathode containing a sharply demarcated pattern of lead inlaid into the indium. Suggested applications for the detector include the recording of neutron diffraction and scattering patterns, pinhole camera photographs of neutron sources, and the neutron shadow graphs. Monoergic neutrons can be studied by proper selection of the foil material with reference to resonance absorption. The counter cell could also be photographed during irradiation and in this instance it would serve as a detector for gamma rays or x-rays. Obviously it enjoys the full sensitivity of a Geiger counter and has the advantage that all irradiated areas can be recorded simultaneously.

PHYSICS (continued)

821 A methane flow beta proportional counter. William Bernstein and Robert Ballantine. AECU-284, nd. 7p. Proposed for publication in Rev. Sci. Instruments.

Chemists have long accepted the sintered-glass Gooch crucible as an adequate tool in gravimetric analysis. The desirability of combining both the standard analysis for an element with the simultaneous determination of a tracer radioactive isotope has led to the design of a counter adapted to count the sample directly in such a crucible. A design was adopted which employs the methane-flow proportional counter principle in an end-on version; a schematic diagram and photograph of the apparatus is included.

822 The standardization and use of radium E sources for absolute beta counting. Benjamin P. Burtt. AECU-320, nd. 30p.

A detailed procedure is given for the determination of the efficiency of mica end-window counters using RaE obtained from discarded radon tubes. For standard end-window counters mounted in lucite or aluminum lined lead shields the percentage rise in counting rate due to sample backing material is independent of: the distance from the source to counter, of the maximum beta energy above 0.6 Mev, and of the thickness of backscatterer above one-fifth of the range of the beta particles in that substance. The saturation backscattering for a given material is practically independent of the counter used, results of other laboratories agreeing with the writer's within 5%. The saturation backscattering is given for numerous backing materials and methods of mounting. Examples are cited of the magnitude of the effect of lateral and vertical displacements of the source. The determination of the absolute disintegration rate of other beta emitters is described using a RaE standard and the constants reported above. The beta emitters need not be mounted on the same material as the RaE standard if the proper absorption and scattering corrections are made.

823 Range energy relations for high energy protons in photographic emulsions. H. Bradner, A. S. Bishop, W. H. Barkas. AECU-323, nd. 1p.

This document is in abstract form; it is reproduced below in its entirety.

Range-energy relations for protons in the region of 30 Mev in nuclear emulsions are of particular interest for the calculation of the mass of artificially produced mesons. The range-energy relations of Lattes, Fowler, and Cuer (Nature 159, 301(1947)) for protons of energies up to 13 Mev in Ilford B.1 emulsion have been extended to approximately 35 Mev, using protons in the 184-in. Berkeley cyclotron. A check point was obtained with the Berkeley linear accelerator. Preliminary measurements at 28.5 Mev yield a range of 3340 μ in 50 μ emulsion evacuated for 5 min. The range of 32-Mev protons in the glass of Ilford plates has been found to be 18% greater than in C.2 emulsion. 16-Mev tracks were 3% shorter in 100 μ C_2 emulsion which had been evacuated for 6 hr, than in emulsion which had been kept at ~80% humidity for 6 hr, and then evacuated for 5 min. 33-Mev tracks in 200 μ C_2 emulsion showed an 8% difference in the same direction.

824 Ring focus in a thin magnetic lens beta-ray spectrometer. Joseph M. Keller, Ernest Koenigsberg, and Arthur Paskin. AECU-335, nd. 1p.

This document is in abstract form; it is reproduced below in its entirety.

Various writers (C. M. Witcher, Phys. Rev. 60, 32(1941); S. Frankel, Phys. Rev. 73, 804(1948)) have suggested an improvement in resolution of a magnetic lens type spectrometer if a suitably located annular orifice is used for momentum discrimination. Primarily to study the application of "ring focus" selection to a thin lens spectrometer, we have calculated the electron trajectories for the Iowa State College spectrometer (E. N. Jensen, et. al., Phys. Rev. 75, 458(1949)). The differential equation of the orbit, for zero angular momentum about the symmetry axis, was integrated numerically on International Business Machines to yield a set of trajectories starting from a point source on the axis. For a fixed range of initial electron directions, different positions of ring focus occur (all at nearly the same radius) for different values of electron momentum per unit magnetizing current.

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The calculated trajectories are used to predict line shapes. Effects of a finite source diameter and of finite angular momenta are estimated by perturbation methods.

825 The distribution of arc-chord differences in scattered particle tracks. W. T. Scott. AECU-338, Feb. 28, 1949. 7p.

Calculations have been carried out to determine if the scattering of particle tracks in emulsions can be more readily measured by the difference between the actual length of track and the chord joining the two ends or by the usual chord-angle measure of scattering. It is concluded that the arc-chord difference is a less precise measure of the scattering. The overlap of the curves in graphic results shows the difficulty in using multiple scattering as an indication of the mass of the particle. The separate chord-angle method can serve to distinguish between protons and mesons in most cases which the arc-chord difference cannot do as well.

826 Rotating illumination method of locating stars in nuclear track plates. W. A. Shurcliff and E. Land. AECU-339, nd. 1p.

This document is in abstract form; it is reproduced below in its entirety.

Stars are usually found by bright field microscopic methods affording limited field and requiring continual focussing up and down. Ordinary dark field illumination fails due to background scattering by fog grains. A rotating azimuth plane illuminating scheme has been developed which provides good contrast for finding stars in emulsions, whose fog background is not excessive. The dark field illuminating rays, roughly in a single vertical plane, are 20-45 degrees from vertical and intersect in the horizontal emulsion. Tracks perpendicular to the illuminating plane gleam; others are almost invisible. If the illuminating plane rotates at one RPS all tracks gleam successively. Magnifying powers as low as 50 × are permissible, affording a field of three millimeters in diameter. Since the effective depth of field is roughly 100 μ, continual focussing is unnecessary, even for 200 μ emulsions. The nuclear track group at Brookhaven National Laboratory have found the method not applicable to differentiating tracks of different types, or to locating individual tracks in very foggy emulsions, but report five-fold faster location of stars in favorable cases of minimum ionization plates.

827 Correlation of counting rate and radiation intensity for several types of Geiger counters. R. E. Zedler, D. M. Davis, and R. Stepp. AECU-346, June 21, 1949. 11p.

A determination of counting rate versus radiation intensity in mr/hr was made for several types of Geiger counters using a 4.87 mg radium source. The relation established between counts per minute and mr/hr is true only for a radium source because the unit mr is an energy unit and because counts per minute is a function of disintegration rate, the ratio of mr to disintegration rate being different for different radioactive nuclei. Results are summarized in tabular and graphic form. Departure of the curves from the theoretical plot of counts per minute versus radiation intensity based on inverse square law becomes appreciable at high counting rates. This departure is due mainly to the dead time of the counter. The dead times are on the order of 100 to 200 micro seconds. The ether-argon counters show the shortest dead time. The counting rate for a particular radiation intensity is also dependent on radiation intensity, the sensitive volume of the counter, the wall thickness, and wall material. The volumes of thin and thick wall glass counters are approximately the same, but for the same radiation intensity the thick wall glass counters have a 28% lower counting rate than the thin wall counters. Although the sensitive volume of the brass counter is about 3 1/2 times that of the thin wall glass counter, the counting rate is only about 2 times that of the thin wall glass. The effect of wall material and thickness on counting rate is evident.

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828 The amplifying effect of irradiations with α-particles, electrons and γ-quanta upon the electroconductivity of cadmium sulfide crystals. H. Kallmann and R. Warminsky. Ann. Physik 4, 69-84(1948) Sept. 20 (in German).

Measurements were made of the electroconductivity of large pieces of CdS crystals, which is caused by irradiation with α-particles, electrons, and γ-quanta. Observations were made both on the currents flowing transversely through the crystal during a continuous irradiation, and on the electric pulses produced by single particles. Only crystals exhibiting strong luminescence effects have high conductivity. While in feebly glowing crystals the current intensities correspond approximately to the number of electrons excited per second, in brightly luminescent crystals the currents are many times stronger, ("amplifying factor"). In many cases intensive currents continue after the irradiation has ceased. In experiments with single particles only a few crystals showed short-lived charge transfers with a high amplifying factor, and a potential of about 10 volts produced by a single α-particle. On crystals of this type current impulses produced by single electrons could also be observed. Most crystals, however, show short current impulses whose intensities do not exceed the order of magnitude of the number of electrons excited. The α-particles, whose action upon the crystal is limited to its superficial layers, produce intensive currents and impulses only when the irradiation proceeds from the negative electrode. This shows that the carriers of the current are electrons. In bombardments with high-energy electrons, which excite the crystal almost uniformly, no such directional effect is observed. Unlike electrons, α-particles show also a strong relationship between the current produced and the intensity of the field. This is due to the fact that the α-excitation takes place at one of the electrodes only, so that the negative charge must be separated from the positive one and moved across the crystal. Through a preliminary treatment of the crystal, the latter's conductivity can be considerably altered. A preliminary irradiation with infrared light reduces by several orders of magnitude the current produced by α-particles. On the other hand, the visible light determines, in similar conditions, currents with a high amplifying factor. Furthermore, a preliminary "rest current" of appreciable intensity should be applied, in order to obtain high amplifying factors in the subsequent irradiation with α-particles or electrons. These facts are explained by a preliminary excitation of the crystal by visible light, (also by electrons, and, in a lesser degree, by α-rays), an excitation that consists in an establishment of transverse conductive bands; the latter can be destroyed by the infrared. All the phenomena studied here should not be ascribed to momentary, shock-like, excitations; it is assumed that the high conductivity of the majority of crystals is due to the presence of long-lived electrons of considerable mobility, called phosphorescence electrons, which establish across the whole crystal bands of metallic conductivity.

829 A comparison of the Lauritsen electroscope with electronic scalers in the counting of radioactive disintegration. C. P. Sonett. Naval Radiological Defense Laboratory Final Report AD-129(I), June 10, 1949. 11p.

Two non-portable Lauritsen electroscopes, one with an alpha-transmitting window and the other with a beta-gamma-transmitting window, were evaluated by comparison with electronic counting equipment and the results summarized in tables. The natural background and the background fluctuations of these electroscopes indicated that for very low intensities of radiation the electronic equipment was more sensitive. For high activity radiation the electronic equipment was found superior because many errors resulted from the inability of the operator to read accurately the fast moving fiber in the electroscope. The Lauritsen electroscope is best suited for measurements of many samples of intermediate intensity, whose energy schemes are similar.

830 Design and performance of a multicellular Geiger counter for gamma-radiation. David A. Lind. Rev. Sci. Instruments 20, 233-5(1949) Apr.

The design problems for Geiger counters which have a high γ-radiation sensitivity are discussed. A description of a Geiger counter consisting of nine individual counters in the shape of pillboxes mounted inside a single envelope is given. The individual pillboxes are 3 in. in daimeter and the

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anode has the shape of a four-pronged spider which is centered in the box. The nine section counter has a flat plateau of about 150 volts, and an intrinsic sensitivity of 25%. A lifetime of better than 10^7 counts was obtained.

831 Detection of ionizing particles with the aid of sulfur crystals. Michel Georgesco. Compt. rend. 228, 383-5(1949) Jan. 31 (in French).

Following Wasastjerna (Soc. Sci. Fennica, Commentationes Phys.-Math. 8, 21(1936)), ionization energies necessary to produce conductivity bands in crystals were calculated with a view to employ the latter as counters. Sulfur was found to be a convenient object. Experiments on 14 sulfur crystals showed that all of them recorded α-particles, while three counted β-rays. The amplitudes of the pulses are proportional to the energy absorbed by the crystal. The effect is directional. This explains the low efficiency of the device when γ-rays are used, the photo-electrons being emitted in all directions. The measured value of the ionization potential agrees with that calculated (5 ev). Because of the low amplitudes of the pulses, strong amplifications are required, thus introducing rather high time constants of about 10^{-4} sec. For a given energy, the pulses appear at a certain intensity of the field; they grow in amplitude, then remain stationary within a rather large interval of values of the potential applied to the crystal, then decrease and disappear. The measurements were made at room temperature.

832 The effect of external quenching on the life of argon-alcohol counters. H. Elliot. Proc. Phys. Soc. (London) 62 A, 369-73(1949) June 1.

A simple multivibrator for eliminating multiple discharges in argon-alcohol counters is described. This circuit has been used successfully in cosmic-ray intensity recording equipment requiring a high degree of stability. It is shown that the increase in counter life which is observed when a multivibrator of this kind is used is probably due to quenching of the discharge before it has spread the full length of the counter wire.

833 Electron collection in high pressure methane ionization chambers. L. E. Beghian and H. H. Halban. Proc. Phys. Soc. (London) 62A, 395-6(1949) June 1 (Letter to the editor).

The collection of electrons in cylindrical ionization chamber containing methane has been investigated at pressures up to 35 atmospheres. Measurements of proton recoils from neutrons from a D+D source show that not more than 15% loss of pulse height occurs. At the maximum pressure used, the saturation voltage is 15,000 volts, and the collection time as measured on a triggered oscilloscope is 1 μsec. The collection time value noted shows good agreement with the value calculated using Snyder's formula ("High Efficiency Neutron Counter for Fast Coincidence Measurement." MDDC-243, P.B. 52,800 (1946)). The efficiency of counting 2.3 Mev neutrons from a D+D source is 12% at 35 atmospheres pressure and the maximum range of a proton recoil at this energy is 2.5 mm.

834 Electron trajectories in a gamma-ray spectrometer. H. Hurwitz, Jr. Rev. Sci. Instruments 20, 318(1949) Apr. (Laboratory and shop notes).

The trajectories of electrons emitted radially inward from a target near the edge of a cylindrically symmetrical magnetic field have been computed in connection with the design of a γ-ray spectrometer of the type recently described by Lawson (Phys. Rev. 75, 433(1949)). An expression for the electron deflection for large electron momentum, p, or a uniform field was obtained; this was found to be fairly accurate even when p is comparatively small and when the field is not uniform. A form more convenient for numerical calculations when the electrons are of low energy is also given. After the calculation for the electron deflection following return to the target radius has been made, the additional deflection corresponding to the path from the target radius to a larger radius can easily be obtained from another expression which is also given.

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835 Fluorescence effects produced by α-particles, fast electrons and γ-rays in solid and liquid naphtalene, diphenyl, and phenanthrene. Lieselott Herforth and Hartmut Kallmann. Ann. Physik 4, 231-45(1949) Feb. 2 (in German).

Experiments are described on the light effects produced by α-particles, fast electrons and γ-rays in crystalline naphtalene, diphenyl, and phenanthrene. The physical and technical light yields, relative to that of ZnS-Ag, are given. The absolute yields are approximately 0.3%, 1.0% and 0.6% for α-particles, and 5%, 7.5%, and 11% for γ-rays. The study of the relationship between the light yield and the temperature was followed up to the melting point. When this point is reached, the fluorescence drops to a vanishing value; while increasing again on subsequent cooling, it regains only about half of the former value. The pulverization of the solidified substance restores the original value of the light yield. The total yield and the behavior in liquid and resolidified states are theoretically discussed.

836 Influence of pH on the properties of photographic emulsions used for nuclear research. E. Picciotto. Compt. rend. 228, 173-4(1949) Jan. 10 (in French).

The pH of photo-emulsions strongly influences their developing properties and the characteristics of the gelatine. Stevens (Nature 162, 526(1948)) has used these relationships for a discrimination between particles of different ionizing powers. The present author found that the pH of the plates Ilford C_2 is equal to 5.90 to 6.30, according to the series; that of Ilford B_2, boron loaded, is 9.00. The measurements, made at 20°C with a glass electrode, were stable and reproducible within 0.02 of a pH unit. Other measurements concerned the swelling properties of these emulsions as a function of their pH.

837 Lecture on some history of the development of radiation counting techniques. W. B. Lewis. National Research Council of Canada Report DL-2, June 17, 1949. 13p.

Techniques developed over the period 1925-34 are discussed. References are made to the proportional counter, scintillation methods, the electroscope, the linear amplifier, the Geiger-Mueller counter, the thyratron ring, the scale-of-two counter, the oscillograph, etc.

838 Luminescent counters. H. Kallmann. Research (London) 2, 62-68(1949).

Some of the experimental possibilities of the luminescent counter are considered. Commercially available luminescent materials are discussed in detail and an alternative method, using CdS as a counting substance, is also described.

839 New method of expanding the scale of a magnetic oscillograph. Ralph L. Goetzenberger, Jr. Instruments 22, 405(1949) May.

A method is described for expanding the scale of a magnetic oscillograph so that a much clearer picture of the amplitude variations during the transient period may be obtained. The circuit used for this purpose is shown; it is a suppression circuit and the increase in scale is adjustable by varying the galvanometer sensitivity control. Oscillogram pictures are shown of the voltage-wave envelope of the 400-cycle.a-c generator output voltage "turning-off" load. In this particular case, by means of the circuit described it was possible to read the oscillation of the envelope 6.3 times more accurately.

840 Note on the preparation of beta-ray sources. Lawrence M. Langer. Rev. Sci. Instruments 20, 216 (1949) Mar. (Laboratory and shop notes).

Suggestions for minimizing the distortion of the spectrum in nuclear spectrometer measurements of the true momentum distribution of β-particles are given. Two techniques designed to prevent "charging" of the source are described and a few procedures which have been found generally helpful in the preparation of the sources are noted.

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841 Nuclear instrument handbook. Nucleonics 4, 97-152(1949) May.

The field of nucleonics instrumentation has been surveyed in a series of related articles. The history and market analysis of the industry is treated by R. E. Lapp in "Survey of Nucleonics Instrumentation Industry. The following group of papers deals with measurement problems in various fields: Nuclear Physics by Sanborn C. Brown, Radiobiology by Howard L. Andrews, Health Physics by David Balber, Radiochemistry by L. Yaffe, and Industry (taken from a report by G. H. Guest). The properties of the materials are discussed in the articles on Photographic Recording Media by Herman Yagoda and Counter Fillings by Sanford C. Brown. A Bibliography on Radiation Detection by H. H. Goldsmith which is 8 pages in length is included as well as a Buyers' Guide which lists manufacturers of various instruments both according to product and alphabetically. (Although published as a special section of the journal, the Handbook may also be obtained as a separate publication.)

842 On the light effects produced in crystals of cadmium sulfide by α-particles and electrons. H. Kallmann and R. Warminsky. Ann. Physik 4, 57-60(1948) Sept. 20 (in German).

A study was made of the light emission produced by α-particles and electrons in large pieces of cadmium sulfate crystals. The crystals, prepared with an addition of a small quantity of silver, showed an intensive red glow at 7,500 A. The intensity of this luminescence approached (80%) that of ZnS-Ag; the absolute light yield of the CdS crystals, acted upon by α-particles, was 19%. Varying glow intensities were observed with crystals prepared without silver; the maximum of the emission band was partly in the near ultrared. Measurements with single α-particles resulted in a value of 2×10^{-4} sec for the duration of a scintillation, (with ZnS-Ag it is less than 10^{-5} sec). Unlike the fine-crystalline layers, the transparent pieces of crystals employed here can be considered as showing only negligible scattering and absorption effects; on the other hand it should be noted that, as a result of multiple total reflections, the light emerges through the narrow surfaces of the edges. Experiments on the relationship between the light emission and the conductivity showed that only crystals exhibiting a strong luminescence are good conductors.

843 On the measurement of short-lived isomers of nuclei. F. K. McGowan, S. DeBenedetti, and J. E. Francis, Jr. Phys. Rev. 75, 1761(1949) June 1 (Letter to the editor).

The method of delayed coincidences between two anthracene scintillation counters has been extended to measure time intervals in the region 10^{-6} to 10^{-7} sec. The pulses from two 1P21 or 1P28 type multipliers are supplied to linear amplifiers whose output signal has a rise time of approximately 1.5×10^{-7} sec and whose pulse height selectors were replaced by circuits which minimize the variation in delay. The maximum variation in delay was measured using pulses of different heights from a signal generator and was found to be 8×10^{-8} sec. A curve of the number of coincidences as a function of delay-time is shown for Au^{198}; a sharp break in the curve occurs at 1.5×10^{-7} sec. It is noted that these results are difficult to reconcile with the half-life of $(2 \text{ to } 3) \times 10^{-7}$ sec reported (Modansky and Wiedenbeck, Phys. Rev. 72, 185(1947)) for the state following β-decay of this isotope. In addition, the existence of short-lived isomeric states of Re^{178*} and Ge^{72*} has been confirmed; the values for the half-lives were determined as $(5.5 \pm 0.5) \times 10^{-7}$ and $(2.9 \pm 0.6) \times 10^{-7}$ sec, respectively.

844 On the mechanism of the effacement of the latent image due to charged particles. Georgette Albouy and Henriette Faraggi. J. phys. radium 10, 105-9(1949) Apr. (in French).

The different factors which influence the disappearance rate of the tracks produced by α-particles have been varied systematically in order to obtain information on the nature of the mechanism involved in the process. The results obtained indicated that for all the factors investigated (temperature, humidity, ambiant atmosphere, substances impregnating the emulsion) it is possible to interpret the phenomena observed as due to an oxidation by the oxygen in the air, which was either retarded or accelerated by the different factors studied. 10 references.

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845 Pressure regulated thin window Geiger-Mueller counter. Michel Ter-Pogossian, J. Eugene Robinson, and J. Townsend. Rev. Sci. Instruments 20, 289-90(1949) Apr.

The use of very thin Zapon or Formvar windows for G-M counter tubes in β-spectroscopy is limited by the fact that the filling mixture of the counter diffuses or leaks through the window, which forbids the use of very thin windows. A pressure regulator is described which will permit the maintenance of a constant pressure of filling mixture even if the window of the counter allows the slow escape of the gas. A thin window G-M counter presenting some improvements is also described.

846 Pulse height distribution analyzer. William E. Glenn, Jr. Nucleonics 4, 50-61(1949) June.

A pulse analyzer is described for the study of radioisotopes which eliminates the usual difficulty of drift in the individual channels by the use of a cathode-ray-tube pulse height selector. Detailed circuit diagrams are shown and the following parts of the analyzer are considered: (1) ionization chamber, (2) preamplifier, (3) pulse shaper and discriminator, (4) Z-axis pulse generator, deflection amplifier and bias system, and (5) output amplifiers. The pulse analyzer tube, which is connected in parallel with a 3-in. cathode-ray tube, contains 50 aquadag-coated copper anodes which are staggered to reduce capacitance. Although the pulse repetition rate is now limited to about 35 μsec, this instrument could have a rate limited only by the speeds of the ionization chamber and the mechanical register. A photoelectric cell system is also shown which has only two channels and is useful in the determination of short half-lives.

847 The scintillation counter as a proportional device. Rosalie C. Hoyt. Rev. Sci. Instruments 20, 178-80(1949) Mar.

The statistical distribution of fluctuations in the gain of a 1P21 photo-multiplier tube has been investigated and standard deviations of 36% to 48% have been found. The distribution in photo-multiplier output pulse heights obtained with Po α-particles incident on a ZnS screen has also been investigated and standard deviations of 27% to 80% found. The importance of the contribution from the fluctuations in gain is shown to be small in this case.

848 A search for crystals that exhibit conduction pulses under alpha-particle bombardment. A. J. Ahearn. Phys. Rev. 75, 1966-7(1949) June 15 (Letter to the editor).

Using experimental techniques reported previously (Phys. Rev. 71, 913(1947)) a search for crystals which exhibit conduction pulses under α-particle bombardment has been made. In most cases specimens 0.25 × 0.25 × 0.20 in. were used. Conduction pulses were observed in the following: diamond, sphalerite (ZnS, cubic form), wurzite (ZnS, hexagonal form), greenockite (CdS, cinnabar (HgS), periclase (MgO), stibnite (Sb_2S_3), realgar (As_2S_2) and carborundum (SiC). Such pulses were not observed in the following crystals: arsenic trioxide, orpiment, sapphire, topaz, beryl, emerald, tourmaline, barium titanate, apatite, calcite, fluorite, lithium fluoride, cerussite, crocoite, potassium chloride, scheelite, wulfenite, mica, magnesium meta aluminate, naphthalene, orthoclase, potassium bromide, rochelle salt, pyrargyrite, quartz, sodium chloride, sodium nitrate, sulfur, titanium dioxide, zinc manganese ferrite, and 50 other species of ionic crystals including tartrates, halides, sulfates, etc., of both organic and inorganic cations.

849 A suggested slow neutron crystal counter. K. A. Yamakawa. Phys. Rev. 75, 1774(1949) June 1 (Letter to the editor).

A single mixed crystal of lithium and silver bromide when annealed and cooled to liquid nitrogen temperature has been found to count ionizing radiation and neutrons. The crystal, grown by Bridgman's method, was 0.75 cm in thickness and 1.2 cm^2 in area and contained approximately four times as many silver atoms as lithium atoms. A field of 2,700 volts/cm was maintained across the crystal while it

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was irradiated by neutrons from a 25-mc Ra-Be source. A 1/32-in. sheet of cadmium, placed between the lead and the paraffin which surrounded the source, served as a shutter for slow neutrons. The differential pulse-size distribution curves obtained with paraffin and lead filters and with paraffin, lead, and cadmium filters are shown. The results obtained seem to indicate that the energy per ion pair for heavy particles, i.e., H^3 and He^4, is not more than twice the value for β-particles. This is much less than the value obtained by Van Heerden (The Crystal Counter, Thesis. Utrecht (1945)) using silver chloride. The counter has an efficiency of about 5% for slow neutron detection. It is noted that this could be improved by using a thicker crystal of lithium enriched in Li^6. It would be expected that a crystal, one- or two-centimeters thick, containing lithium and silver in the same proportions, would have an efficiency of the order of 70%.

850 A 22-inch Wilson cloud chamber in a magnetic field of 21,700 gauss.
Wilson M. Powell. Rev. Sci. Instruments 20, 403-7(1949) June.

A Wilson cloud chamber 22 in. in diameter, in a magnet which produces a magnetic field of 21,700 gauss at the center of the chamber, is described. The magnet is pulsed in synchronism with the 184-in. Berkeley cyclotron and can be operated with a steady field of 10,000 gauss. The use of the instrument for identifying light atoms is discussed briefly.

851 Two new methods of counting neutrons using cadmium sulfide crystals.
I. Broser, H. Kallmann, and R. Warminsky. Research (London) 2, 87-9(1949).

A description of two new neutron counting methods, which utilize the optical and electrical properties of CdS crystals, is given. One method depends on the initiation of luminescence for detection, while the other utilizes the change in conductivity produced under bombardment by energetic particles. The neutrons to be detected give rise to protons when allowed to fall on a paraffin film and the latter produce scintillations or current impulses in the CdS crystal. The scintillations are registered by means of a multiplier, amplifier, and counting device. The momentary changes in conductivity are so large (as a result of the amplifying action in the crystal) that very little subsequent amplification is required. The luminescence method can also be used for observing α-particles produced within the crystal itself under neutron bombardment.

852 Basic electromagnetic theory and the correspondence principles.
Herman M. Schwartz. AECU-271, Feb. 23, 1949. 1p.

This document is in abstract form; it is reproduced below in its entirety.

The first part of the paper is concerned with an examination of the attempts to remove the divergence difficulties of present quantum electrodynamics by superposing quantization upon a suitably constructed divergence-free classical model. It is concluded that this extrapolation of Bohr's correspondence principle is not justified. It is suggested that a more reasonable starting point appears at present to be the assumption that the results and concepts of present quantized electromagnetic field theory will appear as a suitable limiting case in the complete theory of the future. The second part of the paper is devoted to a discussion of preliminary calculations, aiming to develop the consequences of the hypothesis that present electromagnetic theory is a limiting case in the sense that it involves continuous space-time description, and that such description is inapplicable for instance, to the discussion of structural properties of elementary particles. The modification proposed cannot be explained rationally in conventional space-time language any more than pure quantum mechanical effects can be explained rationally in the language of Newtonian mechanics. Thus, for instance, one would have to say that an electron has simultaneously properties of a point and also of a rigid extended structure.

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853 On the external polarization of the vacuum. Hartland S. Snyder. AECU-340, nd. 3p.

The motion of an electron (positron) in an arbitrary external electro-magnetic field determined by the potentials $\phi(r,t,)$, $\underline{A}$ (r,t) is considered. An equation of motion for the electro-positron field is expressed and a general solution of the equation is obtained. A result obtained as an exact consequence of the equations of motion and of the initial conditions used indicates that the problem of positron-electron field in a given external field is not a dynamical problem, but is entirely the problem of the appropriate definition of which states are electron states and which states are positron states.

854 The calculation of interaction potentials from collision cross section measurements. M. C. Kells. J. Chem. Phys. 16, 1174-5(1948) Dec. (Letter to the editor).

A method for calculating interaction potentials from collision cross section measurements by means of a consistent approximation treatment which is simpler than that previously used (Kummer et al, J. Chem. Phys. 16, 739(1948); Rossini et al, J. Research Natl. Bur. Standards 34, 143, 403 (1945); 36, 559(1946)) is demonstrated. The earlier method, which consists essentially of using classical theory and integrating the collision cross section along the scattering path, is shown to be unnecessary. It is noted that the ratio of the potential constant, K, for an exact treatment to that obtained by consistent use of small angle assumptions is within about 1% of unity for l/a (the ratio of scattering path-length to the radius of the receiver) greater than 10. Tabulated values are given for this ratio as well as for a correction factor between the earlier results of Simons, et al, and the author's results.

855 The charge density and magnetic moments of the nucleons. Murray Slotnick and Walter Heitler. Phys. Rev. 75, 1645-63(1949) June 1.

Using pseudoscalar meson theory, the behavior of a single-nucleon system in an electric field is studied. From the electrostatic interaction, the interaction between neutrons and electrons is computed. From the spin-orbit interaction, the magnetic moments of neutron and proton are computed. The calculation is carried out relativistically, with nucleon and pseudoscalar meson fields both subjected to second quantization. The Hamiltonian of the nucleon-meson system is diagonalized to second order in the coupling parameters by two canonical transformations, and transitions induced by the electric field between single-nucleon states are investigated. For pseudoscalar coupling of 282 m_e mesons, estimating the coupling constants for charge-symmetric theory from the observed singlet neutron-proton scattering length (using static nuclear forces), it is found that the volume integral of the neutron-electron interaction potential is about -14 kev $\times (4\pi/3)(e^2/mc^2)^3$, and that μ_p and μ_n are about 1.7 and -5 nuclear magnetons respectively. Results are also given for pure charged theory. Pseudovector coupling is compared to pseudoscalar coupling, and is found to give the same magnetic moments, but a logarithmically divergent neutron-electron interaction. The influence of the contact interaction term is discussed. The results are compared with those of "nonrelativistic" methods and with experimental values, and the neutron-electron interaction is computed approximately for several types of mesons with an improved nonrelativistic method. Charge renormalization and the approximate distribution of the charge cloud around a neutron are discussed. The pseudoscalar meson contribution to the Lamb shift of the 2S hydrogen level is estimated as + 0.08 Mc.

856 The derivation of statistical expressions from Gibbs' canonical ensemble. F. Ansbacher and W. Ehrenberg. Phil. Mag. 40, 626-31(1949) June.

The origin of Gibbs' canonical ensemble and the associated partition sum is briefly discussed. It is then shown that for assemblies of particles obeying the Boltzmann, Einstein-Bose, or Fermi-Dirac conditions the partition sum possesses some simple properties from which the known expressions for the average distribution in energy of particles can be simply derived without reference to either Stirling's formula or the method of steepest descent.

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857 Elementary particles and the principle of reciprocity. Max Born. Nature 163, 207-8(1949) Feb. 5 (Letter to the editor).

The establishment of a satisfactory theory taking into account the present increased number of elementary particles (including the various meson-types) is considered. The "postulate of reciprocity" previously proposed by the author which states that the ultimate laws of physics should be symmetric in space-time x^k and momentum energy p_k (k = 1, 2, 3, 4) is applied to the L-functions corresponding to the various particles; L is defined as the Lagrangian density and is dependent on the spin. If L is known, the field equations can be established; the solutions of these are the wave functions ψ which determine the behavior of the particles. It is noted that only self-reciprocal functions can be used for describing particles. The use of the principle of reciprocity in combination with the principle of relativity can be used to obtain particles with definite rest-masses. The field equations, which have been investigated by Green (Nature 163, 208-9(1949)), are developed in this manner and are discussed. It is noted that it is possible to consider the theory presented as a rational generalization of relativity.

858 Investigation in the Dirac theory of the electron. Émile Durand. J. Math. Pure App. 28, 77-135(1949) Apr.-June (in French).

The paper contains the following subdivisions. I. Wave functions: 1. Wave equations, 2. Transformation of wave functions in a rotation of a universe, 3. Potentials of wave functions in the absence of a field; II. Density magnitudes: 1. Quadratic identities, 2. Differential relations of the first order, 3. Differential relations of the second order, 4. Kinetic momenta from the relativistic standpoint; III. Integrated magnitudes: 1. Integration of relations of the first order, 2. Integration of relations of the second order, 3. Interpretation of the integrated magnitudes by the movement of the center of gravity of the probability.

859 Ionization produced by a spin-possessing particle in a relativistic case. Jean Thibaud. Compt. rend. 228, 171-3(1949) Jan. 10 (in French).

A particle possessing an electric or a magnetic moment interacts strongly with the electrons of a filter (according to a r^{-3} law), producing intense ionizations. The situation is different in the special case of a particle whose mass is very small and whose velocity approaches c; this particle will have two moments, π and μ, equal and rectangular. It is shown that, owing to an extreme flattening of the force tubes in the relativistic case, the ionization produced by such a particle is small. Accordingly, spin-possessing ultra light particles (neutrinos, electrinos) pass through filters much more readily than the nonrelativistic particles.

860 Normalization of the wave function of the deuteron. Ya. Smorodinsky. Doklady Akad. Nauk S. S. S. R. 60, 217-8(1948) (in Russian).

In computation work referring to deuterons it is customary to use Bethe's approximate formula for the wave function of the deuteron, $\psi \cong r^{-1} \exp(-\alpha r)$. The normalization of this function is usually done by employing the model of a rectangular potential well. The author sees a methodological inconsistency in this procedure, since the merit of the theory of the deuteron resides precisely in its independence from any concrete picture of the interaction potential. This inconsistency is avoided by using the more precise theory which has been proposed by the author (Zhur. Eksptl. i Teoret. Fiz. 15, 89(1945) and 17, 941(1947)). The expression for the normalized wave function of the deuteron, obtained by this method, is $f = 1.23\,(2\alpha)^{1/2}\exp(-\alpha r)$.

861 A note on the spin in Bhabha's theory of elementary particles. K. K. Gupta. Proc. Indian Acad. Sci. 29, 274-6(1949) Apr.

The expression obtained by Bhabha (Revs. Modern Phys. 17, 200-16(1945)), $(P_k a^k + X)\psi = 0$, as a general form for every relativistic wave equation for a particle of finite mass, is discussed. In the

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above expression the P_k are differential operators $-i\frac{\partial}{\partial x^k}$, ($x^1$, x^2, x^3, x^0, = x,y,z,ct) and the a^k are four square matrices defining the spin; x is a constant related to the mass of the particles. For every irreducible representation $R_5(n,m)$ of the Lorentz group in five dimensions, one irreducible wave equation for an elementary particle is obtained. Since in the representation $R_5(n,m)$, n denotes the maximum eigenvalue of the 10 operators $I^{K,L}$, (K,L = 0,1,. . . .,4), which form the nucleus of the representation, n is interpreted as the maximum spin of the particle described by the corresponding irreducible wave equation. From the author's calculations, it is concluded that the above equation describes a particle of spin "m" in the state of its lowest rest mass.

862 On the intuitive approach to the spectrum of a wave equation. Philip Hartman and Aurel Wintner. Phys. Rev. 75, 1452-3(1949) May 1 (Letter to the editor).

The dangers of the intuitive approach are indicated in the case of the determination of the spectrum of a wave equation. It is shown in a specific example that intuitive notions on the spectrum may lead to results which are incorrect.

863 On the momentum of a system of two photons. L. D. Landau. Doklady Akad. Nauk S. S. S. R. 60, 207-9(1948) (in Russian).

Studying the problem of the annihilation of slow positrons and electrons, Pomeranchuk (Doklady Akad. Nauk S. S. S. R. 60, 213(1948)) has found that, in the limiting case of motionless particles, the probability of a two-photon annihilation is zero, if the particles' spins are parallel. The present author thought that this circumstance might be a manifestation of some general rule strictly forbidding certain values of the total angular momentum of a system of two photons whose total displacement momentum is zero; such a rule might reflect some specific properties of photons determined by the transverse nature of the electromagnetic waves. The wave-mechanical investigation of the problem showed that, for every value of the total momentum J of the system defined above, only certain states of the system are allowed. The results are summarized in the following table:

	States	
J	even	odd
0	1	1
1	-	-
2k	2	1
2k+1	1	-

Here k is a non-zero positive integer. It is seen that for odd J there are no odd states, and that J = 1 is impossible.

864 On the motion of a vector meson in a homogeneous magnetic field. N. Symonds. Phil. Mag. 40, 636-44(1949) June.

The Kemmer equation (Proc. Roy. Soc. (London) A173, 91(1939)) has been applied to obtain exact solutions for the wave functions of a vector meson in a homogeneous magnetic field. The method used is then generalized and leads to a new form for the second-order Kemmer equation in the presence of an electromagnetic field.

865 On the use of canonical transformations for collision problems. W. Heitler and S. T. Ma. Phil. Mag. 40, 651-66(1949) June.

A perturbation theory for collisions between free particles is developed by means of a canonical transformation with the following features: (1) the state of a free particle is redefined by inclusion of its virtual quanta; (2) the self-energies of all states are included in the definition of the energies;

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and, (3) the amplitude of the collision cross-section is given by an integral equation which is based on the transformed Hamiltonian and is given by an expansion in powers of the coupling parameter. A simplified derivation for the higher order corrections to the Compton effect is given and the analogous problem of meson scattering is discussed.

866 Quantized field theories and the principle of reciprocity. H. S. Green. Nature 163, 208-9(1949) Feb. 5 (Letter to the editor).

The quantization of wave fields described by equations such as $F(P)\psi = 0$, $P = p_k p^k = E^2 - p^2$, where E is the energy operator $i\hbar \frac{\partial}{\partial t}$, and p the momentum operator $-i\hbar \frac{\partial}{\partial x}$, the masses of the different particles being obtained as the roots of the equation $F(m^2) = 0$, which are now required owing to the recently established existence of mesons with several different masses, has necessitated a refinement in field theory technique. This is done by suitably defining a Lagrangian operator. The calculations made indicate that the field consists of particles with different, but definite, masses and each of these can be assigned a definite energy and momentum. The transition to quantum mechanics can be accomplished by expressing the field equations in operational form. When this general theory is applied to Born's self-reciprocal Lagrangians (Nature 163, 207-8(1949)), the picture of a single quantized wave field, in which particles with different rest-masses co-exist without interaction, is obtained. Particles belonging to different eigenfunctions F may, however, interact directly, and it appears to be possible to determine the form of interaction uniquely from the principle of reciprocity, restricted only by the requirements of the conservation of charge, momentum, and spin (angular momentum) which are consequences of the theory.

867 Recent developments in the theory of the electron. Victor F. Weisskopf. Revs. Modern Physics 21, 305-15(1949) Apr.

The development of the theory of the electron is presented in a simplified form, for the physicist with a limited background in quantum theory, with particular emphasis on the flaws in the theory and on recent theoretical work which has been done in an attempt to eliminate the discrepancies with the experimental data. The essential features of both the classical and the quantum theories of the electron are summarized. In considering the relativistic wave equation and the concepts of quantum electrodynamics some of the improvements which seemed to be necessary are noted, i.e., (1) a generalization for high energies in conformity with the theory of relativity and, (2) a consistent treatment of the interaction of radiation with matter. The positron theory is discussed and in spite of the "infinity" difficulties arising in this theory it is evaluated as a major advancement in the development of the theory of the electron, since by means of Dirac's reinterpretation of the states of negative mass it was possible to explain the new phenomena of pair creation and annihilation and to remove several fundamental difficulties of the Dirac equation: (1) the radiative transitions from the ordinary states into states of negative mass are removed; (2) the fluctuation energy is much less sensitive to the structure of the electron because of its logarithmic dependence on the electron radius; (3) the average square displacement of the electron by the field fluctuations is finite and independent of the radius or the structure Since the quantization of the electromagnetic field has failed in several important respects, the authors conclude that the superiority of this theory over the correspondence principle has not been satisfactorily established. However, it is noted that the success of the quantum-electrodynamical concepts in the following two important instances proves that the fundamental ideas of the theory must contain much truth: (1) the agreement with experimental values of the calculated values for the shift of the energy levels of hydrogen-like atoms (due to the zero-point oscillations of the electron) and (2) the correction to the g-factor of the electron. The main achievement of the recent development consisted in finding an unambiguous and relativistically invariant way of separating those effects of the interaction between light and electron which can be interpreted as additional mass and charge, from the other effects which give rise to observable phenomena. The additional mass and charge are contained in the observed values of m and e and can never be observed independently. It is noted that since these magnitudes are still

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infinite in the theory, the interaction of the electron with light quanta of very high energy is still most incompletely understood. The authors speculate that somewhere at very high energies, the internal structure of the electron must play an essential role in a future theory in a way which is completely unknown. This structure appears at present in the form of the arbitrary length "a" which has been introduced as a radius of the electron in order to make the mass and the charge of the electron finite magnitudes. The importance of the recent developments lies in the recognition of the following fact: for problems dealing with atomic energies only mass and charge of the electron are "structure dependent" (meaning dependent on the value of "a" and going to infinity if "a" is chosen zero), whereas all other effects, such as scattering cross sections, energy levels, magnetic moments, etc., can be calculated without making any assumption regarding the structure of the electron. The connection between the satisfactory establishment of a theory of the electron and similar theories to account for meson production and nuclear forces is also considered.

868 The S matrix in quantum electrodynamics. F. J. Dyson. Phys. Rev. 75, 1736-55(1949) June 1.

The covariant quantum electrodynamics of Tomonaga, Schwinger and Feynman is used as the basis for a general treatment of scattering problems involving electrons, positrons, and photons. Scattering processes, including the creation and annihilation of particles, are completely described by the S matrix of Heisenberg. It is shown that the elements of this matrix can be calculated, by a consistent use of perturbation theory, to any desired order in the fine-structure constant. Detailed rules are given for carrying out such calculations, and it is shown that divergences arising from higher order radiative corrections can be removed from the S matrix by a consistent use of the ideas of mass and charge renormalization. The problems of extending the treatment to include bound-state phenomena, and of proving the convergence of the theory as the order of perturbation itself tends to infinity, are not considered.

869 Some cut-off methods for the electron self-energy. J. Rzewuski. Proc. Phys. Soc. (London) 62A, 386-91(1949) June 1.

Some Lorentz-invariant cut-off procedures for the electron self-energy are investigated. Expressions for the self-energy are obtained as expansions in inverse powers of the cut-off constant K. The first term, logarithmic in K, has the correct transformation properties for all the cut-offs. The second term, independent of K, is covariant only for one of the procedures. The remaining terms lack the correct properties in all of the procedures, but contain negative powers of K and, therefore, vanish for $K \to \infty$. The one cut-off procedure which gives a covariant constant term can, therefore, be used for an unambiguous subtraction of the electron self-energy provided that in the final results one proceeds to the limit $K \to \infty$.

870 A study on the oscillator and the Dirac equations (Part III of "A new method for treating and representing wave-mechanical problems"). Hartmut Kallmann and Max Päsler. Ann. Physik 4, 46-56(1948) Sept. 20 (in German).

The present work is a new treatment of the problem of the oscillator and of the integration of Dirac's differential equations for radial wave functions, with the aid of the Laplace transformations. As in previous cases, there is a real advantage in applying the Laplace transformations to problems of this kind. Apart from a considerable simplification of the calculations, results are obtained which lead farther than do those furnished by the usual procedures. This is seen especially in the rapid way of surveying the totality of the solutions, which the new method affords.

871 A trend in contemporary physics. Alexander W. Stern. Phys. Today 2, 21-6(1949) May.

Some of the recent advances in theoretical physics, particularly with respect to quantum electrodynamics, are reviewed. The difficulties in quantum mechanics arising from the prediction of "unphysical" negative energy states and from the divergences of the field theories are discussed and the

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work of Schrödinger, Majorama, Schönberg, Heitler, Heisenberg, and Dirac on these problems is summarized. The implications of Schwinger's work in the field of quantum electrodynamics are considered and the author concludes that the recent advances are essentially an advance in understanding and formalism rather than an advance in the region of applicability of the quantum electrodynamics. The possible significance of the difficulties which still exist with regard to high energy phenomena is considered and related to certain cosmic ray and meson phenomena. A few of the recent fundamental gains in the physics of biology are also noted.

872 The two-distinct-times characteristic of wave mechanics. T. de Donder. Bull. Acad. Roy. Belg. Classe Sci. 34, 314-6(1948) (in French).

A discussion of a wave-equation if five-dimensional space is presented. The second time, as is usually the case, is related to the mass. An external field is included in the equation used.

873 The radiations of Np^{238} and the half-life of Pu^{238}. Arthur H. Jaffey and Lawrence B. Magnusson. AECD-2636, NNES, Div IV, Vol 14B, Feb , 1946. Decl. June 14, 1949. 60p. For publication in NNES.

The radiations and decay scheme of Np^{238} were investigated by absorption methods and coincidence measurements. The suggested decay scheme includes two modes of decay: (1) 60% through a 0.2-Mev beta, followed by a 1.2-Mev gamma (1.8% converted), followed by a 75-kev gamma practically completely converted in the L shell; (2) 40% through a 1.4-Mev beta, followed by the same 75-kev gamma, also converted in the same fashion. X-rays were found, with absorption coefficients consistent with the assumption that they were Pu^{238} L x-rays. Assuming the decay scheme described, the counting efficiency of the Pu x-rays (14 to 21 kev) averages around 2% in an argon-alcohol mica-window G-M Tube. The Np^{238} half-life was found to be 2.10 ± 0.03 days. From the ratio of Np^{238} activity to the measured growth of Pu^{238} alpha activity, the Pu^{238} half-life was found to be 77 yr. A back scattering correction for the zero-absorber (extrapolated) count was evaluated from experimental back-scattering data. It is suggested that the fraction of zero absorber "infinite" back-scattering of betas from a particular substance is independent of the maximum beta energy of the beta-emitter.

874 Decay of gross fission product γ-activity and energy after short bombardments. N. Sugarman, S. Katcoff, B. Finkle, N. Elliott, and J. Knight. AECD-2637, NNES, Div IV, Vol 9B, nd. 21p. For publication in NNES.

The gross γ-activity from the fission products was measured for short bombardments at the cyclotron. Decay curves for varying amounts of Al absorber were obtained for bombardment times of 5 sec, 10 sec, 1 min and 5 min. From the Al absorption curves the average γ-energy was calculated to be ~ 3 Mev for the first few minutes of decay and ~ 1.8 Mev for 1 to 2 hr of decay. The extrapolated curves of curies/fission and watts/fission to 0.1-sec bombardment time were integrated from 10-sec to 2-hr decay. During this time interval 0.8 γ-disintegration per fission occurred, and 2.2 γ-Mev/fission was liberated. An integration data for the time interval from 2 hr to 1000 days of decay shows that 0.9 Mev/fission is liberated in this time interval.

875 Beta ray spectrum of K^{40}. David E. Alburger. AECU-252, nd. 6p.

The 100-fold enrichment of potassium in the K^{40} isotope to 1.2% has recently been achieved. This communication reports the results of a lens spectrometer measurement of the beta-ray distribution from such an enriched sample. The beta-ray intensity distribution was plotted against momentum in gauss-cm. The curve has a maximum of 11.8 cts/min against a background of 18.3 cts/min. A Fermi plot taken from the experimental points is shown. This is linear above 450 kev and gives an end-point energy of 1.40 ± 0.03 Mev. Calibration was taken from the Fermi plot of P^{32} beta-rays measured under identical conditions except for source thickness. An upper energy limit of 1.71 Mev was assumed for the phosphorus beta-rays. The annihilation quantum photoelectron line gave the same calibration figure within 1%. The theoretical intensity distribution for K^{40} corresponding to a Fermi plot linear over the

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entire range is indicated. The Fermi plot for P^{32} was also linear down to 500 kev and had a deviation of about the same shape and magnitude as for K^{40}.

876 A proposed experimental test of the neutrino theory. Luis W. Alvarez. AECU-305, Apr. 18, 1949. 52p.

The experiment outlined in this proposal has the possibility of giving an answer to the question of whether or not the neutrino exists. It is assumed that at the present time, there is no convincing experimental proof that neutrinos exist. The experiment involves the exposure of a stable substance, Cl^{37}, to the "neutrinos" from a pile. After the irradiation, the radioactive isotope, A^{37}, would be separated from the original material, and its activity measured. A^{37} is a known electron-capturing isotope, whose half-life is 34.1 days. The neutrinos would excite the nuclear reaction $Cl^{37} + \nu \rightarrow A^{37} + e^-$. The observed activity would correspond to the reaction $A^{37} + e^- \rightarrow Cl^{37} + \nu$.

877 Shape of beta-spectra of Sr^{90} and Y^{90}. E. N. Jensen and L. Jackson Laslett. AECU-314, nd. 4p.

The beta-spectra of Sr^{90} and Y^{90} have been examined using a magnetic lens spectrometer, and found to exhibit a shape similar to that reported by Langer and Price for the forbidden transition of Y^{91} (Phy. Rev. 75, 1109(1949)). The upper limits found for the Sr^{90} and Y^{90} spectra were 2.05 mc^2 (0.537 Mev kinetic energy) and 5.37 mc^2 (2.23 Mev), respectively. These values, determined in the light of the special form found for the spectra, are similar to those reported by Meyerhof (Phy. Rev. 74, 621,(1948)).

878 Relation between half-life and disintegration energy in orbital electron capture decay. S. G. Thompson. AECU-317, Apr. 27, 1949. 6p.

The large amount of energy data now available for the alpha-emitters and negative beta-emitters in the heavy region makes it possible, through the medium of closed decay cycles, to calculate the total energies corresponding to a number of electron capture decay processes. Using this method a study has been made of the relationship between disintegration energy and half-life in the electron capture process. The present note summarizes the results of a number of such calculations of decay energies and shows how these are connected with the corresponding half-lives. A plot of the logarithm of the (partial) beta half-life vs the disintegration energy for 16 species of isotopes is shown.

879 Columbium 96. D. N. Kundu and M. L. Pool. Phys. Rev. 75, 1690-2(1949) June 1.

Isotopes of zirconium separately enriched in Zr^{90}, Zr^{91}, Zr^{92} and Zr^{96} were bombarded with 5-Mev protons and 10-Mev deuterons. The isotopic composition of the samples is shown in tabular form. A rotating target arrangement (Phys. Rev. 74, 1574(1948)) was employed by means of which two isotopes could be bombarded simultaneously under the same beam and thus any activity produced could be associated with one or the other (or none) of the rotated isotopes. Most of the results given are for the proton bombardments since the deuteron bombardments produced such large amounts of various activities. The isotope Cb^{96} was observed to decay with the emission of β-particles of 0.67 Mev maximum energy and of 1.03-Mev γ-rays; the half-life for this activity was 23.35 hr and it is noted that no x-rays were emitted.

880 Decay of Thulium-170 and Rhenium-186. P. J. Grant and R. Richmond. Nature 163, 840(1949) May 28. (Letter to the editor)

The decay of Tm^{170} and of Re^{186} have been investigated using absorption and coincidence techniques and also by means of a short magnetic-lens β-ray spectrometer. The following results were obtained:

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	β-rays	γ-rays
Tm^{170}	1.00 ± 0.01 Mev	82.6 ± 0.7 Kev
	0.90 ± 0.015	200 ± 10
	0.79 ± 0.03	440 ± 20
	0.45 ± 0.05	
Re^{186}	1.095 ± 0.010 Mev	132 ± 1 Kev
	0.945 ± 0.015	275 ± 5
	0.64 ± 0.030	

881 Directional correlation between successive internal-conversion electrons from Ta^{181}. A. H. Ward and D. Walker. Nature 163, 168(1949) Jan. 29 (Letter to the editor).

Some measurements are reported on the directional correlation between the successive conversion electrons emitted as the result of the emission of two γ-rays in cascade during the decay of Hf^{181} (half-life of 48 days) to the 20-μsec metastable state of Ta^{181}. Four Geiger-Müller counters with 2.3-mg/cm^2 windows were placed around the source, each 6 cm away from it. They were arranged as two pairs to measure the instantaneous coincidence-rates, C, for two angles at the same time. Each counter fed very short pulses (0.3 μsec) into its coincidence unit, so that delayed coincidence were practically eliminated and the correction for random coincidences was small. The anisotropy was found to be: $\frac{C(180°) - C(90°)}{C(90°)} = -0.32 \pm 0.08$.

882 Directional effects in radioactivity. J. A. Spiers. National Research Council of Canada. Apr., 1949. 90p. (NP-912).

A sample of a radioactive substance is maintained at a low temperature (0.01°K or less) and placed in a strong magnetic field (of order 100 kilogauss). By means of a suitable detector the angular intensity distribution (polar diagram) of the radioactive disintegration products is found. Under these conditions there is reason to suppose that after a reasonably short "relaxation" time, a Boltzmann distribution of the initial nuclear spin orientations will be set up, with a preponderance of spin orientations in the direction of the magnetic field (or opposed to it if the initial nuclear magnetic moment is negative). Some departure from spherical symmetry of the polar diagram of emission may then be expected: the object of the present paper is to consider what theoretical predictions may be made as to the nature and magnitude of this effect.

A general result is first derived by application of theorems concerning rotations of axes. It is shown that, whatever the nature of the emitted particle (or photon), the polar diagram of emission will have a certain general form determined by the spin of the initial nucleus, and involving a number of parameters. The values of these parameters (relative intensities of emission in the direction of the axis of quantization of initial nuclear states with different orientations) depend on the particular process considered. The general form is given by

$$F(\theta) = \sum_{M'=-J}^{+J} \cosh M'\beta \sum_{M=-J}^{+J} F_{M'} \left[D^{J}_{M'M}(\theta) \right]^2$$

where,

$F(\theta)$ = polar diagram of emission.

θ = angle between direction of emission and direction of magnetic field.

J = spin of initial nucleus (before emission).

$\beta = H\mu/kTJ$; H = external field

μ = magnetic moment of initial nucleus

k = Boltzmann's constant

T = absolute temperature of substance.

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F_M = the parameters mentioned above.
$D^J_{M'M}(\theta)$ = the irreducible representation of order J of the group of real spatial rotations (in this case a rotation about the y-axis, the magnetic field being taken along the z-axis).

This general form does not include the effect of the magnetic field on the orbits of emitted particles (if charged), an effect which is considered separately. Some special cases of the general form are tabulated for a range of values of J. It is shown that the general form is a polynomial in powers of $\cos^2\theta$ up to $\cos^{2J}\theta$ (if J is integral) or $\cos^{2J-1}\theta$ (if J is half-integral). A particular result is that for J = 1/2 there is no directional effect however strong the field. It is also shown that for small β (in practice for $H/kT \leq 1$), the general form reduces in all cases to the form: $F(\theta)\alpha 1 + A.\beta^2 + B.\beta^2 \cos^2\theta$. Limiting forms for $\beta \to \infty$ (complete line up of initial nuclei) are also given, and it is shown that these are effiectively attained in practice for $\beta \sim 5$ or greater.

883 Fifty years of radium (reprint of two original papers). P. Curie and Madame S.-Curie, with a foreword by O. Hahn. Naturwissenschaften 35, 65-7(1948) Oct. (in German).

To mark the 50th anniversary of the discovery of radium, the following papers by Pierre and Marie Curie are reprinted: (1) A new radioactive substance contained in the pitchblende, (Compt. rend. 127, 175(1898) July 18). An account is here given of the discovery and the chemical isolation of the first element whose radioactivity was much stronger than that of the hitherto known two radioactive elements, uranium and thorium; the authors called it polonium. (2) A new strongly radioactive substance contained in the pitchblende, (Compt. rend. 127, 1215(1898) Dec. 26). The discovery of the second highly radioactive element, chemically related to barium, is described; it is called radium.

884 Gamma-rays from Ta^{182}. J. M. Cork, H. B. Keller, J. Sazynski, W. C. Rutledge, and A. E. Stoddard. Phys. Rev. 75, 1778-9(1949) June 1 (Letter to the editor).

By using the methods of increased absolute accuracy and sensitivity afforded by photographic β-spectrometers, the results of previous investigations of the β-emitter, Ta^{182}, have been extended (Phys. Rev. 72, 581(1947)). Several previously unobserved γ-rays were found; these are included in the electron spectrum which is shown in tabular form. A decay scheme is shown which includes 13 energy levels to account for the 28 observed γ-rays.

885 The half-life of radiocarbon (C^{14}). Antoinette G. Engelkemeir, W. H. Hamill, Mark G. Inghram, and W. F. Libby. Phys. Rev. 75, 1825-33(1949) June 15.

The half-life of C^{14} has been found to be 5,720 ± 47 years by means of the use of mass-spectrometrically analyzed $C^{14}O_2$ as a part of the counter gas in brass-wall Geiger counters. Some of the problems of absolute β-counting with internal counters, particularly the coincidence and end corrections, were investigated and are discussed in detail. 12 tables.

886 In^{118} and In^{119} produced by photo-disintegration of tin. R. B. Duffield and J. D. Knight. Phys. Rev. 75, 1967-8(1949) June 15 (Letter to the editor).

An examination of the indium activities produced by the irradiation of tin with 23-Mev betatron x-rays has led to the identification of two additional periods which can be assigned to In^{118} and In^{119}. The isotopes were produced by the reactions $Sn^{119}(\gamma,p)In^{118}$ and $Sn^{120}(\gamma,p)In^{119}$. The In^{118} decayed by β^--emission (1.5 Mev); the half-life was determined as 4.5 ± 0.5 min. The half-life of In^{119} which also decayed by β^--emission, was determined as 17.5 ± 1 min; no γ-emission was detected, and the β-energy was determined as 2.7 Mev.

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887 Internal conversion of γ-rays and x-rays at the k-capture by heavy nuclei. R. M. Steffen, O. Huber, and F. Humbel. Helv. Phys. Acta 22, 167-224 (1949) (in German).

The radiation from the gold isotopes of mass number 194, 195, 196, and 198 obtained by (p, n)-reactions from platinum have been investigated by spectrometric methods and coincidence techniques using calibrated counter arrangements. Complete decay schemes have been obtained; all of the four Au isotopes were found to decay by K-capture; which in the cases of Au^{196} and Au^{198} is accompanied by β^--emission. The internal conversion coefficients α_K and α_L of the various γ-rays have been carefully measured and the multipole character of the transitions deduced therefrom. By measuring the yields of Auger electrons accompanying the K-capture processes in Pt, the internal conversion coefficients for x-rays were determined and found in quantitative agreement with the relativistic theory developed by Massey and Burhop. 54 references.

888 The interpretation of the K^{42} radioactivity. Franklin B. Shull and Eugene Feenberg. Phys. Rev. 75, 1768-9(1949) June 1 (Letter to the editor).

Using the shell-model, an analysis of the β-spectra of several isotopes for which the forbidden shape has already been observed supports the assignment $\Delta I = \pm 2$ and change in parity for Sr^{89} and K^{42}. The authors suggest I = 2 and even parity for the excited state of Ca^{42} observed in the K^{42} decay. The low energy transition is thus interpreted as first-forbidden with $\Delta I = 0$.

889 Investigation of soft radiations by proportional counter. Part IV. The beta spectrum of Ni^{63}. H. W. Wilson and S. C. Curran. Phil. Mag. 40, 631-6 (1949) June.

Proportional counter investigations of radioactive nickel, which had been irradiated in a pile for a few months and allowed to stand for about 6 months, are described. The existence of the isotope Ni^{59}, which had been previously reported as a positron emitter (Nuclear Forces. L. Rosenfeld. Amsterdam, North Holland Publishing Co. (1948) 506) was not confirmed. However, the investigations provided evidence for the existence of a soft β-source which has been identified as Ni^{63}. It is noted that the half-life of Ni^{59} has been given as 15 years and that the experimental data thus far obtained on Ni^{63} appear to indicate a life-time of at least that order of magnitude. From the histogram of the calibrating radiation (which is given superimposed on the observed β-spectrum), the end-point energy has been obtained as 63 $\pm$ 2 kev. A Fermi plot of the spectrum is also shown which approximates a straight line in the region between 15 and 50 kev.

890 Neutrinos from P^{32}. Chalmers W. Sherwin. Phys. Rev. 75, 1799-1810(1949) June 15.

Beta-decay recoil experiments have been performed using P^{32} sources as a means of determining the momenta of the neutrinos presumably emitted. Although previously such experiments have measured the recoil ion momentum distribution associated with the electrons traveling in a selected direction, in these experiments the addition of a magnetic deflection γ-spectrometer made possible the selection of the magnitude as well as the direction of the electron momentum. The direction of the recoil ion was selected by means of slits and the velocity was determined by measuring its time of flight in a field-free space. Thus, the use of the β-spectrometer and of the recoil time-of-flight spectrometer permitted direct measurements of the electron and recoil momentum vectors; by assuming conservation of momentum, the neutrino momentum was obtained by vector subtraction. In addition, the same apparatus permitted an independent measurement of the neutrino energy; since the β-spectrograph also specified the electron energy, the balance of the energy could be assigned to the neutrino (assuming conservation of energy).

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The sources used were prepared by evaporation in a vacuum and approximated true monolayers. With the aid of radiant heating, the characteristics of these sources were maintained for 5 to 10 days. The surface charges were neutralized by thermal electron "baths."

The momentum measurements indicated that the missing momentum "disappears" in one "package" and separate energy measurements resulted in a determination of the amount of energy which "disappears." The observed ratio of the missing energy to the missing momentum was found to be equal to the velocity of light (±20%), as required by the hypothesis that one neutrino is emitted in β-decay. After experimentally determined corrections are made for the effects of surface scattering of the recoil ions, it is concluded that the missing momentum vector (i.e., the neutrino) most probably enters the same hemisphere as the electron. The experimental points fit best on a curve of the form, $(1 + (v/c)\cos\theta)$. This is in disagreement with previous tentative conclusions by the author (Phys. Rev. 73, 216(1948); 73, 1173(1948)) which are now shown to be in error due to surface losses and scattering of the recoil ions. The following inferences concerning the form of the electron-neutrino interaction have been made on the basis of data obtained:

	Form of neutrino-electron interaction.		
Type of transition	Most probable	Possible	Rejected
allowed	polar vector $[1 + (v/c)\cos\theta]$	tensor $[1 + (1/3)(v/c)\cos\theta]$	scalar and pseudo scalar $[1 - (v/c)\cos\theta]$ axial vector $[1 - (1/3)(v/c)\cos\theta]$
first forbidden	tensor $[1 + (1/3)(v/c)\cos\theta]$ axial vector $[1 - (1/3)(v/c)\cos\theta]$	polar vector $[1 + (v/c)\cos\theta]$	scalar and pseudo scalar $[1 - (v/c)\cos\theta]$

It is concluded that although it is impossible to prove that the neutrino carries off the missing energy in the same direction as the missing momentum, without detecting the neutrino, this seems certainly the most likely possibility. The author also notes that if the P^{32} transition is second forbidden, the extreme forwardness of the neutrino with respect to the electron required by the angular momentum change makes it unlikely that observations of the accuracy reported could distinguish the original correlation due to the basic neutrino-electron interaction. 16 references.

891 Neutron capture γ-rays from Cd. C. S. Moak and J. W. T. Dabbs. Phys. Rev. 75, 1770-1(1949) June 1 (Letter to the editor).

The neutron capture γ-rays from Cd^{113} have been studied by the cloud-chamber method in an attempt to determine the γ-ray energy distribution. A Cd target was placed in a neutron beam from the Oak Ridge National Laboratory pile; some of the resulting γ-rays entered a cloud chamber placed in a 1400-gauss magnetic field, where they struck a 0.0083 cm Pb foil and produced positron-electron pairs. The corrections applied are discussed and the pair-distribution curve obtained is shown. It is observed that the high energy tail of the γ-ray distribution extends to 8.7 Mev (±0.6 Mev). Some significance should be given to this value of E_{max} since in the run 8 pairs were observed with energies above 7.0 Mev while in 1/4 as many background pictures which include the effects of the high energy neutrons in the beam no high energy γ-rays were found.

892 Nuclear isomerism. Emilio Segrè and A. C. Helmholz. Revs. Modern Phys. 21, 271-304(1949) Apr.

The experimental data available on nuclear isomerism and the theories which have been advanced to account for these investigations are treated in this comprehensive review. Following a brief recapitulation of the history of this subject and some useful introductory background, the radiations from isomeric nuclei are discussed both for the case of pure isomeric transitions and for that of isomeric transition accompanied by β-radioactivity. The problem of explaining the mechanism which

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prevents an excited state from radiating its energy in an extremely short time is considered and Weizsacker's hypothesis is discussed both qualitatively and with respect to the following: (1) multipole radiation, (2) selection rules, (3) half-life of excited states, (4) internal conversion, (5) the case of 0-0 transitions, and (6) possible applications of the theory. The production and separation of isomers are discussed, and the decay schemes of the following isomeric nuclei are treated in detail: Br^{80}, Ag^{107}, Mn^{52}, Co^{60}, and Sb^{124}. An up-to-date table of isomers and a bibliography of more than 300 references are included.

893 On the absolute intensity of the radiations emitted by Cu^{61} and Cu^{64}. R. Bouchez and G. Kayas. J. phys. radium 10, 110-9(1949) Apr. (in French).

The intensity of the x-rays and γ-rays from Cu^{64} and Cu^{61} have been studied using an absolute ionization chamber and very thin-walled Geiger-Müller counters. The following branching ratios were determined: (1) for the $\beta-$ to $\beta+$ emission by the Cu^{64}, 2.0 ± 0.15; (2) for the K-capture to $\beta+$ emission, 2.65 ± 0.4 for Cu^{64} and 0.55 ± 0.06 for Cu^{61}. Some difficulties encountered in the theoretical interpretations of the results obtained are discussed.

894 On the disintegration of potassium by K-capture. E. K. Gerling and N. E. Titov. Izvest. Akad. Nauk. Otdelenie Khimicheskikh, 128-33(1949) Mar.-Apr. (in Russian).

The existence of a K-capture in radioactive $_{19}K^{40}$, transforming the latter into $_{18}A^{40}$, which is to be expected according to the rules given by Sisoo (Physica 4, 467(1937)), has been confirmed by Bleuler and Gabriel (Helv. Phys. Acta 20, 67(1947)) by the x-ray method. The present authors found another confirmation of the existence of this process by analysing, with a mass-spectroscope, the isotopic content of argon occluded in minerals containing potassium. Results are given of measurements made on sylvite from the Solikamsk deposits, 200×10^6 years old. The occluded gases were removed from the water solution of the mineral by boiling, then successively separated by sorption on copper oxide, charcoal, and calcium; argon remained free, and its content was found to be 0.507 cm^3 in 1,000 g KCl. The mass-spectrographical investigation showed that, whereas in air A^{36} accounts for 0.30% of the total amount of argon, in sylvite only A^{40} is present. Therefore, air is not the source of A^{40} in the mineral; potassium, through a K-capture, is the only demonstrable source. However, its content is about 30 times lower than that expected from the age of the rock and from the value of the disintegration constant of the capture, 1.9×10^{-9} $year^{-1}$, as determined by Bleuer and Gabriel. If the latter value is true, the discrepancy can be explained by accepting a secondary origin of sylvite from carnallite at a later geological period. According to these views, the total amount of A^{40} in air is formed from K^{40} in less than 10^9 years.

895 On the excited states of Li^7. S. S. Hanna and D. R. Inglis. Phys. Rev. 75, 1767(1949) June 1 (Letter to the editor).

The experimental data available on the excited states of Li^7 are discussed with reference to establishing a satisfactory scheme. The disagreements with the various proposed schemes are considered and it is noted that I = 5/2 seems to be the only single value for the excited state which is compatible with all of the experimental observations. On the basis of theoretical considerations I = 5/2 is shown to be a fairly plausible first excited state. However, some attendant difficulties are noted.

896 On the Geiger-Nuttall relationship. Sukumar Biswas. Indian J. Phys. 23, 51-78(1949) Feb. (See also Nuclear Science Abstract 2-1273).

It is shown that the Geiger-Nuttall relationship is more satisfactory when the curve of log λ (λ = the disintegration constant) as a function of E is plotted for isotopes having the same atomic number, Z. From the theoretical study of α-emission it has been shown that only points referring to

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nuclei having the same atomic number fall on a continuous curve. Even in this case there appears to be some deviation of the actual curve from the theoretical one on both ends, i.e., for nuclei having the shortest and the longest lives. The experimental data of all α-active nuclei have been systematically studied and the modified Geiger-Nuttall curves have been drawn for all elements from Bi to Pu. The α and β stability considerations are used to predict the probable α or β activities as yet unknown. Some of the nuclei suspected of weak α-activity are UX_1^{234}, $MsThI^{228}$ and UY^{231}. 68 references. 11 tables.

897 On the possibility of the disintegration of the nuclide $_{79}Au^{198}$ by K-capture. Gérard-André Renard. Compt. rend. 228, 310-2(1949) Jan. 24 (in French).

In a previous work (Compt. rend. 226, 1269(1948)) the author measured the coefficient of the internal conversion of a γ-ray from the β-disintegration of Au^{198}; this ray must belong to an excited state of Hg and give rise to a corresponding electronic band of Auger. However, if, as has been suggested (Sizoo and Eÿkman, Physica 6, 332(1939) and Jnanananda, Phys. Rev. 70, 812(1946)), Au^{198} disintegrates by K-capture, one should observe the electronic band corresponding to Pt. The author attempted a discrimination by using a proportional counter according to a method described by Curran, Angus, and Cockcroft, (Nature 162, 302(1938)), and by Kirkwood, Pontecorvo, and Hanna (Phys. Rev. 74, 497(1948)). No conclusive results could be obtained as yet. However, by improving the stability of the counter and the amplifying instruments employed, the author hopes to obtain the necessary precise β-spectroscopical measurements in the low energy region, in spite of the very low intensity of the sources used.

898 Angular correlations in successive nuclear α-γ-emission and the excited state of Li^7. Bernard T. Feld. Phys. Rev. 75, 1618-9(1949) May 15 (Letter to the editor).

The various proposed level schemes for the $B^{10}(n,\alpha)Li^{7*}$ reaction are discussed. A method of evaluating the various schemes suggested is given which involves the tabulation of the different schemes in terms of the expected theoretical angular correlations between the directions of emission of the short-range α-particle by B^{11} and 480-kev α-ray by Li^{7*}. Only the old scheme ($^2P_{1/2}$ excited state) and one of the schemes proposed by Jackson and by Feenberg and Primakoff (private communications) lead to unambiguous answers. The other schemes proposed by Inglis (Phys. Rev. 74, 1876 (1948)) and the aforementioned authors result in discrepancies which are discussed. Experiments are now in progress to measure the α-γ-angular correlation of this reaction.

899 Radioactive scandium and vanadium. N. L. Krisberg and M. L. Pool. Phys. Rev. 75, 1693-5(1949) June 1.

An activity which was assigned to V^{47} with a half-life of 33.0 $\pm$ 0.5 min was produced by the reaction $Ti^{47}(p,n)$ with approximately 10 times the intensity with which it was produced by the reaction $Ti^{46}(p,\gamma)$. It was found that V^{47} decays by the emission of a γ-ray and a positive β-particle of 1.65 Mev. Assignment of the 3.43 $\pm$ 0.03-day half-life to Sc^{47} was definitely confirmed by comparing the reactions $Ti^{49}(d,\alpha)$ and $Ti^{50}(d,\alpha)$. It was found that Sc^{47} decays to stable Ti^{47} by the emission of a γ-ray and a negative β-particle of 0.61 Mev. In addition the $Ti^{50}(d,\alpha)$ reaction was found to give the 1.83-day Sc^{48}.

900 Spectrum of α-radiation emitted by RTh+ThX. Salomon Rosenblum, Manuel Valadares, and Marguerite Perey. Compt. rend. 228, 385-7(1949) Jan. 31 (in French).

While studying the magnetic α-spectrum of RTh, the authors found two lines, whose intensities were 1% and 0.4% of that of the ray of RTh; these lines belong to ThX formed during the exposure. The difference $\alpha_0 - \alpha_1$ ThX is 245 kev; von Bayer, Hahn, and Meitner (Physik. Z. 16, 6(1915)) mention a γ-radiation of 250 kev which is attributed by them to ThX. The present authors determined

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$H\rho\alpha_0$RTh/$H\rho\alpha_1$RTh = 1.0079 and $H\rho\alpha_0$ThX/$H\rho\alpha_0$RTh = 1.0236; since the energy of α_0ThX is 5681 kev (Briggs, Proc. Roy. Soc. (London) 139, 638(1933)), the values 5423 and 5338 kev are obtained for the energies of α_0RTh and α_1RTh, respectively; the difference, corrected for the recoil, is 86.7 kev. The intensity of the line α_1 is 39 ± 1% of that of α_0.

901 Three-photon annihilation of an electron-positron pair. A. Ore and J. L. Powell. Phys. Rev. 75, 1696-9(1949) June 1.

Annihilation of an electron-positron pair accompanied by the emission of three photons is discussed for the case of small relative velocity of the two particles. The energy spectrum of the photons is derived and the cross section for the process is calculated. The ratio of this cross section to that of ordinary two-photon annihilation is found to be 1:370. When the result is applied to the ^3S ground state of the positronium atom (electron-positron pair considered as an atom), for which two-photon annihilation is forbidden, a lifetime of 1.4×10^{-7} sec is obtained.

902 Measurement of the adsorption of surface-active agent at a solution-air interface by a radiotracer method. J. K. Dixon, A. J. Weith, Jr., A. A. Argyle, and D. J. Salley. Nature 163, 845(1949) May 28 (Letter to the editor).

The adsorption of a water-soluble surface-active agent at a solution-air interface has been measured by taking advantage of the soft β-radiation from the radioactive isotope of sulfur, S^{35}. The amount of radiation escaping from a solution of a compound containing this isotope comes principally from that fraction of the sulfur which is near the surface owing to self-absorption. Since the molecules of a surface-active agent are preferentially adsorbed at the interface, the radioactivity above a solution containing such an agent labelled with radiosulfur should be higher than the activity from a solution in which no surface adsorption occurs. To investigate this idea experimentally, di-n-octyl sodium sulphosuccinate and sodium sulfate were each synthesized with S^{35}. Activity measurements were made, using a Geiger counter, of solutions of the two compounds having identical concentrations and specific activities. Since the sulfate is not adsorbed at the interface, a comparison of the radioactivity of its solution with that of the surface-active agent permitted a calculation of the amount of agent adsorbed in the interface. An adsorption isotherm obtained in this manner is compared with one calculated by the conventional Gibbs equation. The results obtained indicate that this technique permits a successful quantitative determination of the adsorption which should be generally applicable (using the same or different tracers) to surface phenomena involving mono- or multi-molecular adsorbed layers. It is noted that the radioactivity measurements indicate that, after the agent had formed a unimolecular layer, a further increase in bulk concentration caused further adsorption at the interface.